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VOL. 11, NO. 1 MARCH, 1936

THE QUARTERLY REVIEW of BIOLOGY

PLAYING WITH A DOG

By E. S. RUSSELL
Berkhamsted, England

THE title of this paper may appear frivolous. It has been chosen deliberately, with a serious purpose. I propose to show how an attentive study of the behavior of a dog, as it plays and as it goes about the ordinary business of its life, may bring to light some general principles of animal behavior which are of the profoundest importance.

In a dog's world its master is the dominant figure, and its relations with its master, as for example in play, make up a big slice of its life. It is not quite true to say that a dog never plays alone, but play is predominantly a social affair; a dog plays with other dogs, other familiar animals and with human beings. I have known dogs, both of them as it happens Toy Yorkshire Terriers (females), which played when alone. Both these bitches would pick up a small object and throw it a little distance with a sideways jerk of the head, running after it to pick it up and throw it again. (Their pedigrees show that they had no common ancestors in four generations.) The "killing" game referred to below might also be regarded as solitary play. As a rule, however, a dog must have a partner in its play, and it is with the games my dog Gina plays with me that I shall begin. Gina is a smooth haired Fox Terrier bitch, with an admixture of rough haired ancestry, and at the time of writing (August, 1935) nearly four years old. She has been under general observation by my wife and myself since she was six weeks old. No attempt was made to train Gina in any elaborate way; she was not subjected to experiment in the laboratory; she was in fact allowed and encouraged to be the experimenter as well as the experimentee. The observations here recorded are for the most part transcribed from notes jotted down from day to day.

THE BALL GAME

When about a year old, Gina was taught to retrieve a ball. It is natural for a terrier to chase and pick up a ball that is thrown, but some slight training is required to ensure that the ball is brought back. This was quickly achieved by ignoring the ball if dropped at some distance, but picking it up and throwing it again if it was dropped within reach. The command "Fetch" was also asso-

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ciated with finding and bringing back the ball. This retrieving behavior was very rapidly established, and soon underwent a significant extension, for Gina would spontaneously seek out her ball and bring it to us to throw. If we paid no attention she would drop the ball near us, sometimes on our foot, and bark vigorously. The game in fact soon became an obsession with her, and if permitted she would play it in and out of season.

Now in this simple everyday behavior there are many things that deserve close attention. The whole action of chasing and retrieving the ball is a typical example of directive or "goal-seeking" behavior, and as such shows certain characteristics which are found in all behavior. First, it has all the objective marks of attentive behavior. If I pick up the ball, Gina approaches in a state of tension and alertness, ears pricked up, and her eyes fixed upon the ball. She is irresponsive to other stimuli, ignores another dog yapping at her side, or the call of her mistress. She follows with the closest attention the slightest movements of the hand holding the ball. This concentrated attention on the ball is particularly noticeable if it is lying on the ground near my foot and I am about to kick it; the slightest preparatory movement of the foot is closely observed by the dog and followed by a slight movement of its head in the same direction. (That a dog responds to very slight, even involuntary, cues given by the experimenter is of course now well known, but failure to recognize this fact caused some confusion in the early days of laboratory experiment.) When I throw or kick the ball, the dog sets off in the direction indicated by the movement of my hand or foot, and when she comes within reach she snaps it up. Through long practice she has become expert at catching it on the bounce. If the ball goes out of sight in the long grass Gina searches for it, hastily quartering the area with her stern in the air, her tail moving rapidly with full steady strokes, her nose to the ground. This particular tail action is so regular and typical that one can always tell from it that she is seeking or hunting. She may find the ball, if she passes close to it, probably by smell, and then she brings it back to me; or the search may last for some minutes and yield no result, when she returns to me and barks, just as she does when she wants me to play ball with her.

We may single out the following characteristics of this train of action as typical of behavior in general—(1) it is an activity of the animal as a whole in relation to something outside it; (2) the activity of the animal is concentrated on the course of action which is being pursued; (3) the activity is directed towards a particular end-state or completion, the retrieving of the ball; (4) it shows persistence, for if the ball is not found at once the search is pursued till the likely ground has been covered, perhaps more than once; (5) cessation or continuance of the action is governed by result; if the ball is found, searching stops; until it is found, searching goes on, at least for a time; (6) it shows variety of effort, not only in the actual searching, but more conspicuously in the shift over to a new type of action if the search has proved unavailing, for the return to me is undoubtedly to be regarded as an indirect method of obtaining possession of the ball.

Although this description is couched in objective terms, referring only to observable characteristics of the action, it bears a close resemblance to the well known definitions of attentive and conative behavior given by such psychologists as Hobhouse (1926), Stout (1913), and McDougall (1923). It seems to me quite impossible to give an adequate description of behavior without reference to its directiveness, its aiming at a specific and definite end-state or completion. I say "end-state" deliberately and not "end," because of the ambiguity inherent in the latter word. The distinction between end-state and end has been so clearly brought out by Stout that I cannot do better than quote him. The word *end*

> may mean either (1) actual satisfaction of conation, or (2) the conditions of satisfaction as they appear to conative consciousness before the satisfaction is actually and completely attained. In sense (1) the term *end*, whatever else it may imply, implies also its ordinary literal meaning of termination or cessation. . . . The end, in this sense, implying actual satisfaction, and with satisfaction the cessation of the conative process, may be called by way of distinction the *end-state* or *terminus*. We may then confine the word end to its second meaning as *object* of conative consciousness—the conditions of satisfaction as apprehended by the subject before actual attainment (1913, pp. 123, 124).

While there is more in Gina's behavior than the "closure" of an unstable dynamic system, as Gestalt psychology would have us believe, it is not necessary to assume that she clearly conceives the end or goal of her behavior and acts with deliberation and forethought. Psychologically, her activity appears to lie at a lower level altogether; the connection between perception, impulse and action is more direct; her "mental" activity is, as the classical psychologist would say, perceptual rather than conceptual, just as our own is when we are actively engaged in playing tennis. A teleological explanation of her behavior, that is to say an explanation in terms of ends, is in fact unnecessary and, probably, psychologically unsound. We should therefore in describing her behavior use the word *end-state* rather than *end*, in accordance with the important distinction drawn by Stout.

By using the neutral word end-state we avoid the teleological implications of the word end. What we cannot leave out of a characterization or definition of behavior, without emasculating it, is the objective phenomenon of directive, persistent activity which tends actively towards the attainment of a specific and definite end-state or completion.

It would be out of place here to attempt the demonstration that behavior in general shows the same objective characteristics which we have noted in Gina's retrieving game, namely whole-action with reference to a specific end-state, persistency with varied effort, action governed by result. It is sufficient to point out that these objective marks of behavior stand out clearly in Jennings' classical account of the pursuit of one *Amoeba* by another (1915).

So far we have considered mainly the executive or motor aspect of Gina's behavior in retrieving a ball; let us now turn to its perceptual aspect.

Before Gina was trained to play with a ball, it was to her an indifferent or neutral object—it elicited no attention, no behavior. In the course of training it became a significant object, or, to introduce here a convenient technical term, it acquired *valence*, became a *valent* object. (On the previous use of this term see below.) By this I mean simply that Gina manifested attention and behavior in relation to it. Now soon after a ball—any ball—acquired valence, other objects, *which could be used in the same way*, also acquired the same or similar valence. On a country walk she would pick up and deposit at my feet stones, pine-cones, sticks and broken boughs. I have known her dig out a half-buried stone and bring it, or pull at a root to break it loose. The picking up of sticks and stones is no doubt due to the fact that in the absence of a ball I may throw these for her. Other objects which have been noted as having ball-valence are an orange, a gooseberry, a bottle cork, a raw potato, a box of safety matches, a child's wooden cube, a clean dry bone, and what is really rather extraordinary, a rubber boot-sole and a long-handled hearth brush. All these objects she has on occasion brought to me and dumped at my feet, with the obvious expectation (clearly deducible from her attitude and behavior) that I should throw them for her to retrieve.

Now these objects have nothing in common, except that they are "pick-up-able" and potentially retrievable, yet they have the same or similar valence. We may say then that they are *equi-valent*, for they elicit the same kind of behavior.

What can we deduce from these facts? Not, certainly, that these objects look alike to the dog—definite evidence will be given below that the dog can distinguish clearly between different forms and appearances. Nor does there appear to be any common sensory quality among them—they are diverse in form, color and smell; they have in common only a certain restriction in size, and the quality of moveableness so that the dog can easily pick them up and carry them. It is then their *functional* value, functional valence, which makes them stand out in the dog's perceptual world, causes the dog to notice them and make use of them.

That the dog does not confuse these objects with one another is demonstrated by two simple observations. First, there is for Gina a definite order of preference among her balls proper; one type in particular, a hard black rubber ball, is so obviously preferred before all others that it is always known to us as "Gina's best ball." Some other balls, especially soft ones, possess so little valence that she is apt to drop and lose them after a little while. The second observation is the following:

> Playing with a square piece of wood which I throw to her, G. loses it. Hunts for it, comes across and looks at a piece of firewood (a thin piece of wood some five inches long) with which she has played earlier in the day, but does not pick it up. A minute or two later finds a second square piece similar to the first, which she picks up and brings to me. 10.6.35.

Before passing on to describe another kind of play, I wish to refer in a preliminary way to the most important fact about valence, namely that it is relative to the attention or "interest" of the animal at the moment. This is rather prettily shown by a very simple observation which I transcribe with some expansions from a note made on 18.7.35.

> I take Gina up the garden, playing ball with her. When she nears the collection of stakes and odd wood lying on the grass which previous experience has shown her to harbor voles, she runs there, still holding ball; in a few seconds she drops ball and goes nosing for voles, wagging her tail in the typical hunting or seeking manner. Pays no attention to the ball, even when I pick it up and throw it for her.

The valence of the ball is therefore dependent upon momentary attention or "interest"; when this is diverted to another object, eliciting a new course of action, the valence of the ball drops to zero. Thus it is attention or interest that essentially determines response to particular objects, rather than the objects *per se*. It is not of course denied that the mere sight of an object may directly arouse interest and attention, as when Gina, walking quietly along, suddenly lights on her ball and immediately seizes it. But in one way or another valence and attention are intimately bound together.

THE PENNY TRICK

I have described in another place (1934) how a penny became a valent object in Gina's perceptual world, acquiring the value of a means towards acquiring cheese, of which she is inordinately fond. She was taught in October or November

1932 to retrieve pennies, receiving as a reward a little piece of cheese, and shortly afterward she developed the habit of looking for pennies and bringing them in the expectation of reward. She would retrieve any coin, from a sixpence to a half-crown, thrown to her. Not only so, but other small objects acquired valence as means towards cheese. Here are some notes, made at the time.

19.1.33. I place penny in crevice of chair; Gina goes and digs it out. Afterwards she goes twice to chair to look for penny. Later, no penny being available, she brings me a bottle cork and drops it at me. I give her cheese; she brings cork again. Five minutes later, I throw her the cork; she brings it back as she would a penny and is given cheese. Goes and looks for cork or penny; again looks in chair.

20.1.33. Cork again brought at dinner time. Did not bring a large spoon which fell off table, nor when it was thrown.

22.1.33. Small brass hook brought for cheese—spontaneously.

11.9.33. At dinner, during meat course, Gina found box of book-matches on floor and brought it for reward; she was given a small piece of meat. She did this several times. Later I fetched a piece of cheese rind. Gina obviously expected me to throw a penny—her usual response to the presence of cheese—but when I pointed out the book-matches she brought them as she would a penny, retrieving them when thrown, dropping them as she does a penny, to attract attention.

It appears from these incidental observations that the response is not specifically to a penny, but extends to other coins and to other small objects, which are used as functionally equivalent to a penny, are therefore, in our nomenclature, ***equivalent*** with it. The basis of equi-valence in this case appears to be the small size of the objects used.

Equi-valence is shown also in another kind of play, which consists in vigorously shaking and "killing" a glove, a rubber mat, a velvet polishing pad, a sock or a rolled-up stocking, and other similar things. The action is similar to that employed by Gina in killing a vole, and this play is probably to be interpreted as the killing of a substitute rat or vole or other small prey. A favorite article employed in this "killing" game is the long-handled hearth-brush mentioned above as being used as a "retrievable." It is more usually employed in the killing game. It has had for Gina a peculiarly strong attraction from her earliest youth.

It appears from this that one and the same object may, at different times, have a different valence, being employed in different games. Another case of change of valence is the use of a bottle cork either as a retrievable, with ball-valence, or as a means towards cheese, with penny-valence. The two actions, retrieving pure and simple, and bringing an object for reward, are of course very similar, but differ in certain details related to their "intention." Thus one is never allowed to pick up an object having penny-valence, if Gina can help it, while a ball-object is meant to be picked up.

I mentioned above that a clean dry bone may have ball-valence. I have recorded a case (1934) where a dry bone had, to all appearance, a pup-valence, and I may briefly recapitulate the facts here. Gina when exhibiting definite signs of pseudo-pregnancy dug up a buried bone and lay beside it for three hours, growling if approached, but not grabbing it as she would had she been treating it as food. She brought it into the house and curled herself round it. In the evening she dug a hole and buried it. Clearly the bone was treated during the day as functionally equivalent to a pup.

BURYING FOOD

A bone, if not completely bare and dry, has of course normally a high food valence. As such it figures in the habit shown by dogs (and some other carnivores) of burying food. This form of behavior is in all probability "instinctive" or independent of experience (Pitt, 1927), and as such it is curiously stereotyped or rigid in the details of its carrying out. Normally a dog buries its bone in soft earth, scraping a hole with its fore-feet. The food is placed in the hole with its mouth, and earth pushed over it with its nose. I have never seen a dog cover over the food by scratching—invariably the nose is used, in typical sweeping motions towards the food. The end-state aimed at, though not always achieved, is the covering of the food from sight. The action may be carried out in typical form in unusual environments and with unusual material. Thus I have noted Gina "burying" a piece of food by pushing over it with her nose some withered grass which was still attached by the root. On another occasion she buried food up against a boot-scraper, covering it neatly with straw and grass-stems pushed over it with the nose. The action may be carried out even indoors; thus on 14.8.32 Gina tried to bury a piece of biscuit on the dining room hearth, which is tiled, by pushing over it with her nose the plug and lead of the electric fire. The biscuit was, however, quite incompletely covered. A male Toy Yorkshire which we had used to bury sweets, biscuits and other tit-bits under cushions and in chairs, moving them to another spot if we threatened to take them.

Here is another case, noted on 12.9.32. "Gina takes piece of dog biscuit, leaps on bed, lays it on top blanket, sweeps blanket with her nose radially towards biscuit, exactly as if pushing earth over it. Instinct satisfied if biscuit by chance is pushed under pillow or down crevice between bed and wall, i.e., out of sight, more or less." In this and some other "abnormal" cases there was no preliminary digging or scratching with the feet.

I have dwelt on these details because, though not strictly relevant to our main theme, they illustrate an interesting feature of instinctive behavior, its tendency to become independent of the normal perceptual situation and to be carried out in more or less routine form almost as a symbolic or ritual action.

According to Miss Pitt (1927) dogs do not usually dig up and eat buried food; this is not my experience with the three dogs (Gina and two Toy Yorkshires) I have observed in this connection. Not only did they usually select with care a "suitable" spot in the garden for their burying operations, but they very often sought out the spot afterwards and dug up the food. For a rather remarkable case of topographical memory for buried food exhibited by Gina after a lapse of 24 hours I may be permitted to refer to my book (1934, p. 6). However, the main fact about burying to which I wish to draw attention is that it has reference to a class of objects, namely surplus food, for all sorts of food may be buried as well as bones, and, so far as some dogs are concerned, nothing but food objects. Functional value, functional valence, is again decisive.

PERCEPTUAL WORLDS

In all the cases we have described, the ball game, the penny game, the "killing" game, and the burying behavior, it is important to note that valence is not a quality of objects *per se*, independent of the dog; it is the dog's "interest" or need or "intention" that essentially determines what objects (or what characteristics of objects) shall possess valence. To Gina attracted by an area signifying voles a ball loses all its valence; to a dog satiated with food even meat has no positive valence and may even acquire negative valence, causing aversion. It is the fact of the relative nature of valence that renders intelligible the circumstance that the same object may have different valence at different times.

A second point to note is that, in many cases at least, the initiative, so to speak, rests with the dog, who actively singles out, pays attention to, such objects as for the moment are significant in relation to its needs or interest. The valent objects need not be actually present; the dog then goes and looks for them.

The general picture of the relation between the dog and its perceptual or behavioral environment which these observations give us is very different from that which would be furnished by a physiological approach. The facts do not seem to fit in with the theory that behavior is reducible to simple stimulus-response relations, considered as physico-chemical events. It would appear that neither stimuli taken separately, nor patterns of stimuli (wholes) are the real determiners of behavior, but only such perceived objects or events as possess valence in relation to the dog's psychobiological state at the moment.

It is a significant fact, to which sufficient attention is rarely given, that the number and kind of valent objects or events in an animal's environment are distinctly limited—to many physical and chemical stimuli impinging on its sense-organs it makes no behavioral response whatever. Thus to a dog many of the objects in a room are behaviorally neutral—the pictures on the wall, the pattern of the carpet, and, in general, all objects that do not bear some functional relation to its needs and desires.

We are so accustomed to perceiving a vast number of discrete, easily discriminable objects in our own behavioral environment or perceptual field that we are apt to assume without thinking that the world appears to a dog in a similar highly articulated and meaningful form. We forget that a dog's interests are vastly more restricted and severely practical; it perceives (i.e. responds to) mainly such classes of objects or events as are of functional importance to it, bear some relation to its needs and "interest," and these objects and events are limited in number and kind as compared with those that possess valence in our more complex perceptual world, which is the expression of our more varied and more extensive interests, both practical and contemplative. We should not expect a dog to discriminate and attend to books, or chairs, or tables, as such, but only to them as functional objects—as chewable things, or things that may be sat on or walked upon.

Objects possessing valence for the dog are, for instance, the fire or the stove before which it may lie, its cushion and its bed, the chairs on which it is or is not allowed to sit, the table which is forbidden but on which food may be found, the door by which exit may be made, the window through which it may look out, and so on. Small and insignificant objects or events may have a high valence, as for example the rustling of a paper bag, which for Gina "means" biscuits or sweets or potato-crisps, and elicits immediate attention. For many dogs, crumpled paper lying in the road has high positive valence and is investigated as possibly containing food. One dog which we had used to investigate all parcels brought into the house, nibbling a bit off the corner of each to find out what was inside—parcels had an acquired positive valence for him, through his often finding food therein. In a house in which we lived previously, the click of the latch on the garden door had high valence for

Gina and brought her racing towards it, in order to escape into the road.

In these cases, we are dealing with objects or happenings which have acquired valence through the animal's experience. But the same principle appears in unlearned or instinctive behavior. Thus, to take only one example, to a hermit-crab robbed of its "house" any small rounded movable object has positive valence and is closely investigated, and especially any hole or crevice in it, any possible opening into which the hermit crab may insert its tail (Hertz, 1933).

It should be a primary task in the study of any animal's behavior to find out what objects or events possess valence, whether positive valence inducing approach, or negative valence determining avoidance. It is, from a psychobiological point of view, far more important to draw up a table of valences than to investigate the reaction of the animal to simple physicochemical stimuli, many of which are behaviorally neutral. The study of simple stimulus-response relations may yield physiological knowledge of value, but it hardly seems an adequate method for attacking the real problems of behavior.

"TRANSFER OF TRAINING"

If a certain range of things has a common functional quality or valence, one might expect that the dog would manifest similar behavior with respect to them, and would not *in practice* distinguish between them, though they might appear to the dog different in certain respects. We have seen this to be the case in Gina's response to several classes of equi-valent objects.

I am inclined to think that a similar explanation may be valid for at least some cases of so-called "transfer of training." This is strongly suggested by some simple experiments in which Gina learned to nose up the lid of a box or a file-case to obtain food or a ball. The first experiments were carried out on the evening of 5.11.34. The box in which Gina's best ball is kept was used for the sixteen tests, lasting 1–5 minutes each, then carried out. It was familiar to Gina by sight, but never before played with. It is a casket-shaped wooden box, of a dark brown color, 15 cm. high, 21 cm. long, 10 cm. wide; the lid projects slightly, measuring 11.7 cm. by 23 cm. In each test Gina was shown a piece of biscuit, or cheese, or a ball, which was then placed in the box and the lid closed. Though she was keenly intent on the box and occasionally pushed at it with her nose or clawed it, she did not succeed in opening it that evening. That the box had acquired "means-to-food" valence was clearly shown by the occurrence of a special behavior trait, consisting in biting my foot if it approached the box. This response is always given by Gina when food is thrown down for her; often she will not begin to eat until the ritual of biting the advancing foot is gone through. Her failure that evening I put down mainly to her expectation that I would open the box for her, as I do when I give her the ball; she often lay beside it, looked up at me, and whined. The fact that she was not allowed to seize the food or the ball when they were shown her prior to being placed in the box seemed also to invest them with a "forbidden" character.

The tests were resumed on the following evening—this time with a cardboard file-box laid on its side with the lid uppermost. It measured 15.5 by 5.2 by 24 cm., and the lid did not project; it was mottled red and brown in color. She succeeded at once in the first test, failed in the next three, obviously waiting for me to open the case, then succeeded with ease in the next four tests, lifting the lid by pushing it up with her nose. In the next test, the ninth that evening, she was given the original wooden box, which she opened in 12 seconds. "Transfer of training" was immediate and complete.

Next morning she opened the file-box without hesitation on several occasions. In the evening she opened both file-case and box after some delay, due to starting on the hinge. She had no clear perception of the difference between the hinge and the edge of the lid. After a few more successful trials on 8.11.34, no further experiments were made until 4.1.35, about eight weeks later. She then opened the box rapidly, though she tried the hinge first; there was complete retention of learning.

On 7.1.35 an interesting experiment was carried out by chance. I had laid on the floor alongside my chair the open drawer of a wooden file-cabinet which I was using, full of papers. Gina immediately paid attention to it, inspecting its contents closely and standing up on her hind legs for it when I lifted it off the floor. It had evidently some valence for her, like the box and the file-case. On the same evening she opened at once the lid of a large red file-case which she had not previously seen.

These experiments are of course somewhat crude and incomplete but they do show clearly that at least two or three "box-objects" were functionally equivalent, as possible food containers. Gina did not *in practice* discriminate between the box and the file-cases, but fastened on the essential functional property they had in common, namely their openableness as a step towards acquiring food or a ball, both objects of high valence.

As is well known, a single painful experience may be sufficient to give a child or an animal an aversion not only from the specific object which has caused it, but also from all other similar objects. The burnt child dreads the fire—all fires. When Gina, leaping unawares out of a hedge, was bowled over by a motor van, being slightly hurt and thoroughly scared, not only this van, but motor vehicles in general (even when stationary) became for some months objects of aversion, acquired strong negative valence. Obviously Gina did not perceive *this* motor van as such, as we should do, but merely as a large, moving, noisy and smelly thing, which one experience endowed with a pain or danger valence. Other objects with similar characteristics subsequently encountered were not in practice distinguished from the original one and were accordingly perceived as dangerous and avoided. There was, it seems, a practical generalization on the basis of a few (to the dog) outstanding characteristics. It should be mentioned, however, that the driver of the van, who was already known to Gina, and came to see if she was hurt, acquired in her eyes for some time, as an individual, a negative valence.

ON VALENCE, CHANGE OF VALENCE AND EQUI-VALENCE

It will be obvious to the professional student that the interpretations offered above of Gina's behavior are related in many respects to the views of Lewin, Tolman and Klüver, and that the general point of view adopted is very similar to that of J. von Uexküll, for we have been dealing with the dog's "Umwelt," or perceptual world, or behavioral environment, or phenomenal field, to use the various expressions that have been coined for the purpose. I take this opportunity of expressing my indebtedness to all these authors, and particularly to J. von Unexküll, who, though he does not use the word "valence," deals in his latest book (1934) with the perceptual worlds of animals in a manner very similar to that adopted here. His "Merkmale" and "Wirkmale" correspond closely with "valences," and what he calls the "Wirkton" of an object is exactly what I mean by "functional valence." (I have myself been advocating since 1924 the same essential point that an animal's behavior is to be interpreted with reference to its own perceptual world.)

In the dog's perceptual world certain objects and events stand out, as we may judge from the fact that they are attended to, or sought for, that they elicit behavior. Such objects and events I have here proposed to call *valent*, or possessing *valence*. The word valence is borrowed from Lewin (1931) (See also the translators' note on p. 77 of Lewin, 1935), being the accepted translation of his expression "Aufforderungscharakter," but the use here proposed is perhaps an extension of Lewin's usage, though the basic meaning remains the same.

One might instead of "valence" use the words "meaning" or "significance," and I have above sometimes used the expression "functional significance" or "funcional value" to designate one kind of valence. But there is a distinct advantage in using a neutral or technical word like valence, for it is by no means certain that the animal is aware of the significance or meaning of the valent objects or events in respect of which it shows behavior. This may well be so in cases of learning but it seems improbable in many cases of instinctive behavior, especially of the lower animals. Thus the fish-leech *Piscicola* responds to any source of water-vibration, not too far away, by directing its anterior end towards it. This may lead to its fixing itself on a fish, and water-vibration might accordingly be called a sign-stimulus, "meaning" the approach of a possible host. But we have no warrant in the behavior of *Piscicola* for assuming that it is aware of the meaning of the stimulus; all we know is that in certain conditions it responds in a particular way to this particular kind of event in its environment, and that sometimes this response leads to the specific end-state or completion of the response, namely attachment to a suitable host. The fact that the response is adaptive does not justify us in concluding that it is purposive, in the sense of implying foresight of the end or goal. It is better then simply to say that water-disturbance possesses valence for *Piscicola*, instead of calling it a sign-stimulus or significant stimulus. Whether or not my generalized use of the word corresponds with Lewin's original use, we agree on the essential point namely that valence is relative to the animal's momentary state (or nascent tendency); it is not a quality of the object or event *per se*. This is strongly emphasized by Lewin, who writes:

> The valence of an object usually derives from the fact that the object is a means to the satisfaction of a need, or has indirectly something to do with the satisfaction of a need. The kind (sign) and strength of the valence of an object or event . . . depends directly upon the momentary condition of the needs of the individual concerned; the valence of environmental objects and the needs of the individual are correlative (1935, p. 78).

Valence is, however, dependent not only on need, but also upon what one may best describe as "interest" or "nascent intention." Thus Gina is diverted from the ball game to a vole hunt, not by need of food, but by interest in the chase. (She does not eat the voles she catches.) The vole area has an acquired positive valence, which arouses her attention and interest, and induces her to search in it.

The fact that valence is relative to needs, or interest, indicates that it is to be considered as a quality of the animal's own perceptual or phenomenal world. This being accepted, it is easier to understand how one and the same object in *our* perceptual world may have several different valences in an animal's world, changing from one to another according to the animal's needs and "intentions." A striking illustration of this fact is afforded by the observations of Brock (1927) on the "Umwelt" of the hermit crab *Pagurus arrosor*.

To be in a state of behavioral equilibrium with its environment *Pagurus* requires (1) a gastropod shell into which it can insert its abdomen and carry round with it as a mobile house, (2) one or more specimens of the sea-anemone *Sagartia parasitica* planted on its shell, (3) a supply of food. If any one of these necessary requirements is absent the *Pagurus* takes steps to make good the deficiency. Thus if the anemones are all removed from the house of a well fed *Pagurus* it will search round, and finding a *Sagartia* tap it and stroke it to induce it to lose tonus and slacken its hold on the bottom; it will then swing it up and press it against the shell until it adheres. The *Sagartia* has in this case its normal valence as "something to be placed on the shell." If, however, a *Pagurus*, which has been long deprived of food, but possesses a shell, well covered with anemones, is given a *Sagartia*, it will strip pieces off it and eat them. The *Sagartia* has lost its normal valence and is treated as having food valence. Finally, a well fed *Pagurus* lacking a shell, treats any free lying *Sagartia* as a possible substitute house, trying to press its abdomen into the hollow of the pedal disc. Here the anemone has house valence. Thus one and the same object, as it appears in our perpetual world, may have three different valences according to the dominant need of the animal perceiving it.

> It can be shown by analysis of the extensive observations and experiments of Brock that *Sagartia* does not exist for *Pagurus* as a specific and individualized object, but simply as the bearer of certain perceptible characteristics, some of which make it a suitable object to place on the shell, others a food object, and another still a (rather ineffectual) house object. According to the dominant need, so does the attention of the *Pagurus* become directed to the characteristics of *Sagartia* that are relevant in connection with the satisfaction of the need, that are valent in the particular situation. Other objects showing some of the same characteristics may also be treated as having similar valence (see Russell, 1935).

In a small way, we have seen the same phenomenon of change of valence in considering Gina's behavior. Thus for Gina a cork may have ball valence or "means-to-cheese" valence; a dry bone may be treated as a ball or as a fantasy pup. The last example suggests an interesting parallel in the behavior of the child with reference to its toys. As Lewin says, "Exactly the same physical object may have quite different sorts of psychological existence for different children and for the same child in different situations. A wooden cube may be at one time a missile, again a building block, and a third time a locomotive" (1935, p. 76). In all cases it is the need or the interest of the animal that determines what objects, or which characters of objects, shall have valence, and what kind of valence.

In our definition of valence nothing is asserted about the *kind* of objects and events that may be expected to possess valence, but if valence is relative to needs and interest it follows that valent objects and events will in general be such as have relevance to the animal's normal behavior in maintaining its existence, in assuring its development, in reproducing its kind. They will accordingly have, as a rule, functional or biological significance (though the animal need not be aware of their biological significance).

Valent objects and events are classifiable according to needs or "interests" or "desires"—in practice, however, by the type of behavior they elicit. Thus we may distinguish objects and events having food or feeding valence, water or drinking valence, danger or flight valence, foothold valence, play valence, and so on. They can be grouped in two main classes—positive valences and negative valences—according as they induce approach or avoidance. Objects may have a specific means valence, as a step towards reaching some particular end-state or satisfaction; for example, pennies and other small objects have for Gina means valence in relation to the eventual possession of an object of high food valence, namely cheese. In a biological sense, food objects also are means towards an end-state, the restoration of depleted biochemical resources, but they have psychologically an immediate value of their own, as satisfying hunger. Means objects in the limited sense have on the contrary no immediate value as satisfying a need—Gina does not eat her penny.

It is convenient to refer here to some of Tolman's views and concepts which receive support and illustration from my observations on Gina.

Tolman distinguishes as an important factor of the psychobiological field what he calls *manipulanda* qualities. "By manipulanda" he writes, "I would understand those properties of objects which actually support (i.e. make possible) *motor* manipulations. . . . Graspableness, pick-upableness, throwableness, heaviness (i.e. 'heave-ableness') and the like—these are manipulanda" (1933, pp. 397–98). Gina's balls and ball-substitutes, which are characterized essentially by pick-upableness and eventual retrievableness, are excellent examples of objects possessing manipulanda qualities. And, as we have seen, many objects stand out in Gina's perceptual field because of what she can do about them—warm places to lie in, chairs to sit in, objects to tear up and destroy (when she was a pup). These are objects and places having *functional* valence. So for the child, as Lewin points out, many objects acquire valence by reason of their "*functional possibilities* (the Wirkwelt in von Uexküll's sense). The stairs are something that one can (or cannot yet) go up or down, or something that one climbed yesterday for the first time" (1935, p. 77). Even more important than manipulanda qualities in Tolman's view are the means-end-relations existing in the perceptual field.

> "By means-end-relations" he writes, "I wish to designate those interrelational properties between environmental objects, whereby the 'enjoyment of' (i.e. the 'commerce with') the discriminanda and manipulanda constitutive of one such object will (or will not) actually lead on to an immediate possibility of 'enjoyment of' (commerce with) the discriminanda and manipulanda of such and such other environmental objects" (1933, p. 401).

The intermediate or means object is called by Tolman a sign-object, leading on to the signified object or "significate." This relationship is well exemplified in Gina's penny game, where the coin or other equi-valent object is the sign object and cheese the significate. In our suggested terminology the coin has "means" valence in relation to the food valence of the cheese.

In conclusion, a few words on equivalence. It is to Klüver (1933) that we owe the first thorough study of this important phenomenon. In his well known investigations of the behavior of monkeys much attention was given to determining to what extent a particular "stimulus" or stimulus-pair could be changed without altering the character of the response. Thus after training a monkey to pull in the lighter (or the heavier) of two boxes of definite weight, he found that the response was given correctly to the lighter (or the heavier) of any pair of manipulable boxes which differed sufficiently in weight. Further, the original conditions of the experiment could be altered in many respects without upsetting the correct response.

> "In the critical experiments" writes Klüver," we found a large number of situations to be equivalent to the stimulus situation during training in the sense that there was no disturbance of the response. The changes introduced in the critical situations were changes in the 'absolute' and 'relative' weight of the boxes; changes in the material and in the optical appearance of the gliding surface; changes in the pulling-in device; changes in the optical appearance of the box; changes in the distance of the boxes from the cage; changes in the distance of the boxes from each other; changes in the number of boxes; changes in the 'affective' value of the boxes" (1933, p. 59).

Other experiments with visual and auditory relata showed the same thing—a considerable range of variation was possible without altering the correctness of the response. There were of course limits to this variation, and when the limits were overstepped the altered stimuli became "non-equivalent." Klüver rightly attaches great importance to determining the "range of equivalence" of stimuli. Whereas most workers have been at pains to discover the limits of discrimination of like stimuli, it was Klüver's aim in these experiments to discover to what degree dissimilarity could be pushed without upsetting the response. In doing so he has opened out a most fruitful field for research. Many extraordinary cases have been recorded of the equi-valence, so far as behavior is concerned, of the most diverse objects, and many of the so-called "aberrations" of instinct arise from these bizarre assimilations. Thus Yerkes (1915) has shown that a female monkey may cleave to her still-born babe for weeks, until nothing but a desiccated fragment of skin is left. Zuckerman (1932) has observed similar behavior in female baboons, but points out that a clinging attachment to furry objects may be shown also by young baboons and by males. He quotes also an observation by Loveridge regarding a female Cercopitheque to whom the warm body of a dead rat was given. She took the greatest interest in the corpse, examining the fur for fleas and "nursing" it; she clung to the rat for two days, until it was green and stinking. Such cases can "in large part be explained as the operation of a response common to females of apparently all ages as well as to males, and one for which the significant stimulus can be greatly altered—from monkey baby to dead rat—without effectively altering the character of the response" (1932, p. 301).

Wiesner and Sheard (1933) have shown that the retrieving response in nursing rats may be elicited not only by their own young up to a certain stage, but by the young of other rats, by young mice, young rabbits, young kittens and young chicks. "The rat is not 'interested in' her own young because they are hers (and recognizable as such by some odor or other property) nor because they are rats, but because they are small young creatures; and any object to which these terms apply is 'her young' to the rat" (1933, p. 135). All these objects are, in our nomenclature, equi-valent with the usual object retrieved, the rat's own young.

It would be easy to adduce other instances of equi-valence, extending over a considerable range of objects. I shall content myself with making some tentative suggestions as to the possible bases of equi-valence. We have first of all such cases as are exemplified by Gina's response to motor vehicles in general, after a painful experience of one in particular. Here it is probable that the objects concerned are not separately distinguished; they have some characters in common which have acquired a danger valence, and in the danger situation the dog ignores their differences. Many cases of instinctive response also come under this heading, where there is response, not to an individualized object, but to certain valent characteristics of it. It is well known, for example, that a fly which normally oviposits in carrion will on occasion lay its eggs on a flower that has a carrion smell. Here the decaying flesh and the flower have a common valent characteristic; the fly does not seek out carrion *qua* carrion but merely "something with a carrion smell." A careful study of the perceptual field in instinctive action would probably show that in many cases there is response, not to an individualized object, but merely to certain, quite simple, valent characteristics, which may be shown by other objects besides the normal one. This point has been very clearly brought out by Miss Smith (Mrs. Bartlett) (1923) apropos of a discussion of "aberrations" of instinct like that of the carrion fly. "In no such case," she writes, "does the animal recognize the object which prompts the instinctive action as a single, specific, individualized object; it responds rather to certain qualities, qualities which, it frequently happens, are common to many different objects, while the remaining qualities characterizing the object in question are ignored" (1923, p. 81). In other words, only certain characters or qualities of the object, as we perceive it, possess valence for the animal, the others are, so far as we can tell from the animal's behavior, simply not perceived, form no part of its perceptual world. And the valent qualities, occurring as qualities of another object (an object *to us*) may also elicit the instinctive action.

A second group of equi-valent objects are those that can be used in the same way, which are therefore ***functionally*** equivalent, or possess the same or similar "manipulanda" valence. An example of this class is the group of heterogeneous objects which are used by Gina as "balls." So too a chimpanzee will use all sorts of objects as "tools" for drawing into the cage food objects which are out of arm's reach.

In a third group of equi-valences it would seem that a strong and unsatisfied need or desire may invest with valence objects which would not normally possess valence or come into the picture at all. We know that valence is relative to needs; it is understandable therefore that, where the need is imperative, behavior in attempted satisfaction of it may bring into its ambit objects which normally would be neutral or might even possess negative valence. A case in point is afforded by the incubating behavior of the Emperor Penguin (*Aptenodytes forsteri*). This bird nests in the middle of the Antarctic winter, and so strong is its "drive" to incubate its eggs that it will continue to sit on frozen eggs. "Indeed, in their desire for something to hatch, some who had been deprived of their eggs were seen to be attempting to incubate pieces of ice, and, unlike Adélies, they seem ever ready to snatch and foster the young of their neighbors" (Levick, 1914, p. 136). They will also carry about and nurse frozen and lifeless chicks until the down is worn away.

Yet a fourth category of valence is required to cover cases where a "fantasy" value is attributed to more or less neutral objects. Thus a child may use a wooden cube to represent or stand for a railway engine, or a set of marbles to represent a company of soldiers. I can see no other explanation of Gina's temporary adoption of a bone than to assume that it was to her a substitutionary or fantasy pup. In such cases a valence is conferred on the object that has no real warrant in the perceptible characteristics of the object.

But we must leave the subject of equivalence here. It is one of immense importance and deserves far more study and research than it has yet received. It will show more clearly than any other line of study the real value, and indeed the indispensability, of the hypothesis that an animal's behavior must be interpreted with reference to its own perceptual world, its own "Umwelt."

I have been concerned in this paper mainly to show how the almost casual study of a very ordinary dog contributes to the support and elaboration of some important modern views in animal psychology.

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WHITEHEAD'S PHILOSOPHY OF ORGANISM

AN INTRODUCTION FOR BIOLOGISTS

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INTRODUCTION

THE concept of Organism is one which is very much to the forefront among philosophical biologists at the present time, and it appears in contemporary psychology in the doctrine of Gestalt. Whitehead is frequently invoked as an advocate of Organism, but it must be doubted whether many biologists are fully acquainted with his views, which indeed belong more to the domain of philosophy than of science. Nevertheless it must surely be of great importance to biologists who desire to work with any conception of Organism to know what an acknowledged great thinker, both in metaphysics and mathematics, believes to be involved in the concept of parts united into an organic whole—that is to say, a whole which has a unity of its own which cannot be expressed simply as a summation of its parts. This involves, for Whitehead, a discussion of the nature of reality; and, indeed, the nature of organisms, in the sense in which that word is commonly used by biologists, occupies only a minor part of his discussions.

Unfortunately, Whitehead's exposition must prove extremely difficult to anyone not well read in metaphysics, and accustomed to the modes of reasoning of philosophers, and he rarely helps the reader by application to a specific example. The following is an attempt to give a descriptive outline of his system for biologists who desire to learn something of the general nature and scope of this oft quoted theory of Organism. The writer is quite incompetent to discuss the metaphysical questions involved, and he has of necessity passed over many of them without even mention. The reader must therefore constantly bear in mind that any lack of conviction in the reality of Whitehead's system which he may feel in reading this account should be ascribed to the crude way in which it is presented, and especially to the almost complete absence of any indication of the reasoning lying behind Whitehead's conclusions. Moreover, the reader should realize that this is not merely a summary, but also an interpretation, and an interpretation may be misleading. Many of the specific applications are the present writer's. For all these reasons, this account should be taken, not as a sufficient indication of Whitehead's philosophy, but as an introduction to the study of his own works.

Whitehead's philosophy, so far as we are concerned with it, is set out in the trilogy, *Science and the Modern World*, 1926 (referred to in the following pages as *S.M.W.*), *Process and Reality*, 1929 (*P.R.*) and *Adventures of Ideas*, 1933 (*A.I.*). Of these, *Process and Reality* stands out as containing the complete system. In fact, although Whitehead says that each book may be read separately, the present writer found *Science and the Modern World* unintelligible in regard to many fundamental issues when taken by itself. Chapters XI-XV of *Adventures of Ideas* contain a general account of the main ideas involved. But *Process and Reality* contains the system set out as a whole, and in detail, the other books being chiefly helpful in giving the student a general orientation.

The student of Whitehead will find Dorothy M. Emmet's book *Whitehead's Philosophy of Organism* a most valuable commentary on *Process and Reality*.

Reality as process

Whitehead develops his system primarily from consideration of conscious human experience—and at the other end of the scale, from the conclusions of mathematical physics. "Any doctrine which refuses to place human experience outside nature, must find in description of human experience factors which also enter into the descriptions of less specialized natural occurrences." (*A.I.* 237)

Reality is thus conceived as a process of experience (only rarely of the conscious order). Both introspection, and physics, tell us that this process is not continuous, but atomic. An electron is a vibratory series of experiences; human experience is also a succession of atomic processes of experience, each lasting in this case perhaps about $\frac{1}{10}$ to $\frac{1}{2}$ a second (the "specious present"). Each moment of experience is a transition between two worlds, the immediate past and the immediate future. But as human experience, e.g. a train of conscious thought, tells us, the past still lives in the present, and the present acts into the future. Whitehead's system deals primarily with the nature of the atom of process (of experience) itself, and with the relation between atoms of process, especially between a given atom of process and its immediate predecessors and successors. That is to say, how the past is immanent in the present, and this acts into the future.

Accordingly, the essence of a thing is not what it is, or where it is, but what it does. How it receives the past into its own constitution, and transmits itself to the future—its "objective immortality."

In order to understand Whitehead's system it is necessary from the outset to hold steadily in view this notion of reality consisting in process and not in substance. This is consistent with the physical analysis of a lump of matter into a collection of ultimate processes (such as electronic vibrations). A single one of these processes, if it be incapable of further analysis, is the physical aspect of an "actual entity." (Cf. *S.M.W.* 190–198). The present writer, who has but a superficial knowledge of physics, must be content to quote Bavink in this connection. (*The Anatomy of Modern Science*, 1932, p. 199.)

> . . . . wave and oscillation in themselves have no other meaning in modern physics than periodic changes of some quantity, no matter of what kind. When now everything that can be stated regarding the processes in question depends only on the form of these processes, while the nature of the quantity itself which changes according to the wave formula has become a matter of complete indifference, then all that plays any part in physics is the process itself, and it does not in the least matter what the something is in which the process takes place. . . . . This fundamental idea needs only to be carried to its logical conclusion for us to see that a final state of physics is not merely imaginable but already very nearly reached, in which the notion of a substance is no longer made use of, since everything which can be stated physically is founded upon the law of the processes.

Reality, then, consists in *process*, not in substance supporting qualities. The final real things of which the world is made up are "*actual entities*," which Whitehead also calls "actual occasions" to emphasize the fact that they are atoms of process and not of substance. The two terms, entity and occasion, are therefore synonymous.

Although experience is atomic, the atoms (actual entities) can be analysed into parts when considered as objects, but as experiencing subjects they are indivisible wholes.

The word *process* refers to the process of becoming, or self-formation, of actual entities. An actual entity is a "drop of experience" (*P.R.*, 25). Experience, or feeling, implies both a subject which feels and an object which is felt. The object felt (in Whitehead's system) is a complex of feelings, originating as feelings transmitted to the present actual entity by previous entities whose own feelings originated in the same way. "An actual entity is . . . . . an individualized feeling. . . . . Its feeling is its whole nature, in which it becomes and perishes." (Emmet, 181).

The conception that the world, including the physical world, is composed of entities which are "drops of experience" or feelings will seem to many people a strange one. But Whitehead does not use the term "feeling" in the sense of conscious feelings. Even "conceptual feelings" very seldom have the conscious form. Energy in the language of physics corresponds with emotional intensity in Whitehead's language. The wave lengths and vibrations of physics are "pulses of emotion." A quantum of energy is possibly a single actual entity. "Physical science is the science investigating spatio-temporal and quantitative characteristics of simple physical feelings" (*P.R.*, 337). To quote Emmet again (p. 142) "We must bear in mind that 'feeling' is here used throughout as the purely general term for any kind of acting or being acted upon, in such a way that the make-up of the subject is affected." It is essential that the reader should understand the word "feeling" in this sense wherever it occurs.

THE LIFE HISTORY OF AN ACTUAL ENTITY

We will start by attempting to sketch out the life history of a simple actual entity. This life history consists of three essential phases:

(1) The initial phase, in which the general nature of the atom of experience constituting the actual entity is determined by its relation to the preceding actual entities (the responsive phase). For instance, the actual entity which arises at the space-time location at which the period of a light wave has just completed itself, has itself the nature of a similar period. The actual entity arising at the location where a phase in a stream of conscious thought (occupying the duration known to psychologists as the specious present) has just completed itself, tends to continue the stream of thought.

(2) A final phase in which the actual entity faces the future as itself an agent determining the character of new actual entities (the phase of satisfaction).

(3) In the higher types of actual entities, these two phases are connected by a complex phase called the supplemental phase, the term indicating the mental activity, with a measure of freedom, concerned in this stage. In the simpler types of actual entities—as found in inorganic bodies—this phase is negligible (though never completely absent) i.e. the initial phase passes over quickly and almost determinately into the final phase.

Let us now take in more detail the life history of a simple actual entity—one for instance forming a component of an inanimate material object. We at once meet the difficulty that we cannot easily fix on a particular class of entity to use as a sample. For individual actual entities (except those in the stream constituting our own conscious processes) are not available for inspection. Not only is there the logical difficulty that we cannot know anything about the internal processes of an actual entity except by inference, and by analogy with our own conscious processes, but even as physical objects they escape direct inspection. For exceedingly short temporal durations (e.g. the period of a light vibration) and minute extensions of space are concerned. Anything big enough, and lasting long enough, to be perceived consists of a vast number of actual entities, just as they consist of a vast number of atoms, electrons, etc. Even electrons are probably not the limit of physical simplicity—that is to say, consisting, at any one moment, of a single entity. But for the sake of example, "an electron" may be conceived as consisting of a stream of electronic entities or occasions, each occupying an exceedingly short temporal duration.

An actual entity or occasion occupies an atomic duration (time being the succession of atomic durations) which however may be of very different extent for different entities. It is also located in space, in the sense that it has a regional standpoint from which its prehensions are made and its own causal influence extends.

Subjective aim

As we have seen, its real nature is an atom or act of experience. At its moment of origin its only specific characterization is its *subjective aim* (or end-in-view) and its corresponding *subjective form*. The nature of these depends upon the location of the nascent actual entity in the *extensive continuum* (described below: the most prominent feature of the extensive continuum is its space-time aspect). In general, the subjective aim and form of the nascent entity are determined by, or taken over from, the actual entity which has just completed its life history, and added itself to the general *creativity*, at that point of space and in the immediately preceding temporal duration (the Doctrine of the Conformation of Feeling, *A.I.*, 235). The life history of the actual entity is essentially the fulfilment of its subject aim. The notions of creativity and subjective aim will be amplified later.

Initial data and objective datum

The just nascent actual entity is therefore a feeling or atom of experience with a subjective aim conformable with that of its contiguous predecessor or group (nexus) of predecessors. But experience needs something (objects) to experience. These are also provided by its contiguous predecessors, and through them, by the actual entities of its whole preceding world, as will be seen later. These constitute the *initial data* (for feeling) of the nascent actual entity, and they, or rather, aspects of them enter into the constitution of the new entity to form the *objective datum* for the new actual entity. They have been *objectified* in the new entity, which on its part is said to have *prehended* them, or received them into its own constitution. An aspect of an actual entity means "a feeling entertained by an actual entity" (Cf. *P.R.*, 334).

The difference between the plural and singular forms of the terms initial data and objective datum is significant. The initial data present a multiplicity of feelings "to be felt" by the new actual entity. The objective datum which is actually felt is a unity formed by the *concrescence* of the originally separate feelings. (*P.R.*, 312).

(This concrescence into an objective datum of the feelings provided by the initial data is illustrated in perception, which is a complicated form of conscious prehension. We see objects as wholes, not as a mere multiplicity of the parts composing them.)

Prehension

The idea of prehension is fundamental for Whitehead's system. His simplest characterization of it is as follows:

> A prehension involves three factors. There is the occasion of experience within which the prehension is a detail of activity; there is the datum whose relevance provokes the origination of this prehension; this datum is the prehended object; there is the subjective form, which is the affective tone determining the effectiveness of that prehension in that occasion of experience (*A.I.*, 227).

The contribution of the various actual entities in the initial data to the general character of the objective datum will of course vary greatly, and depends partly upon relevance to the subjective aim. (In perception, again, we perceive our environment in its relevance to our activities.)

The feelings transmitted to the nascent actual entity by the initial data are *physical feelings*, and objectification is the reproduction in a succeeding actual entity of a feeling in a preceding actual entity. This is the *efficient causation* of science, subjective aim being *final causation*. It expresses the effect of one thing upon another. "A simple physical feeling is an act of causation. The actual entity which is the initial datum is the 'cause', the simple physical feeling is the 'effect' " (*P.R.*, 334). The notion of cause in Whitehead's philosophy will be taken up again later.

Eternal objects

But we have to remember that the actual entity is an experiencing subject, with a subjective aim at a specific form of self-realization. Certain external feelings have been appropriated into its constitution, and now constitute its own physical feelings. How is the actual entity going to utilize these for its self-realization? This "how" involves the *conceptual feelings* of *eternal objects*.

We must now consider the nature of these eternal objects—a strange-sounding term to the layman. Eternal objects determine *how* the external world enters into the constitution of a new actual entity via its feelings (*P.R.*, 207). They are "forms of definiteness," an expression which has great significance in Whitehead's system. Actual entities and eternal objects are alike entities. But an entity is *actual* only when it is self-realizing. An eternal object, though an entity, is not an "actual entity," because it only functions in the self-creation of an actual entity, not in its own self-creation (*P.R.*, 34).

This function is expressed by saying that the eternal object has *ingression* into the actual entity. The actual entity itself prehends the eternal object, just as it prehends its initial data.

To most scientists, the existential status of the eternal objects will probably not be at all clear, and the conception, and the language in which it is expressed, may even be repugnant to that vast majority of scientists who are not in a position to appreciate the metaphysical reasoning which led Whitehead to adopt it. But it is enough for our purposes that the idea expresses the notion that the possibilities of self-realization of actual entities from their initial data are not infinite; in other words, that the possible ways in which the initial data can enter into the constitution of new entities as their objective data are specific and limited, and that these possibilities are named by Whitehead, eternal objects. "The essential point in this view of nature is to show that, while events come to pass and perish, their flux sustains permanent and recognisable characters, which make possible sense-perception and natural science" (Emmet, 113). Eternal objects are therefore universals, qualities, etc. The ideas of hardness, motion, man, drunkenness, are eternal objects (Cf. *P.R.*, 72).

Consider our perception of a stone. Every different stone will produce a slightly different objective datum for the percipient actual entity in the brain. If it were not for these forms of definiteness there could be no perception of stones as such. The idea of a stone would not exist. Not only would all objects which we know as stones be perceived as unique objects (without the common quality of stoniness), but an individual stone would be perceived as a different unique object on every occasion of perception, since it would practically never happen that the conditions of the perceiver, the stone, and the perspective from which it was perceived, were identical in two acts of perception.

But perception is a conscious form of prehension, and similar considerations can be applied throughout the whole order of nature. Without these "forms of definiteness" there could be no *classes* of objects (such as atoms, men) at all. Since every actual entity must have initial data different from that of every other actual entity, and prehend them from a unique perspective, no two actual entities would ever complete their processes in the same way were it not for the limitation of possibilities imposed by the eternal objects.

A physical feeling is a feeling of an actual entity (in the initial data). It is a merely passive being acted upon by another actual entity (Emmet, 147). The feeling of an eternal object is a conceptual feeling because it belongs to the new actual entity in its capacity of a responding subject. In perception, physical feelings may be compared with the reception of the stimulus, the eternal object characterizing the objective datum is the percept—e.g., the stone.

The subjective form of a conceptual feeling of an eternal object has the character of a valuation of that eternal object—i.e. its value for the realization of the subjective aim of the actual entity. This (principally in the higher types of actual entities) will determine whether it is to be allowed to enter into the concrescence of feelings which is the developing actual entity.

To return to the life history of our simple actual entity—say, an electronic occasion. The overwhelmingly dominant feeling in its objective datum is the objectified preceding electronic occasion or entity (which also determined the subjective aim of the present actual entity). But this preceding electronic occasion was similarly conditioned by the electronic occasion before that, and so on. The eternal object correlate to the physical feelings of the nascent electronic occasion we are now considering, will therefore be the same as for the preceding one. "From each physical feeling there is the derivation of a purely conceptual feeling whose datum is the eternal object determinant of the definiteness of the actual entity, or of the nexus, physically felt" (*P.R.*, 36). This is the category of Conceptual Reproduction (*P.R.*, 141). In this instance, therefore, the eternal object is necessarily appropriate to the subjective aim, and the conceptual feeling of it is received into the concrescence.

The life history of the actual entity is now nearly over. It attains *satisfaction* of its subjective aim through concrescence of the physical and conceptual feelings into one final, determinate, definite, feeling. The completed actual entity is a feeling which has felt feelings—and the final stage of that feeling (its satisfaction) is necessarily bound up with the sort of feelings it has felt. The genesis of this final determinate feeling out of the feelings felt (which are at once objects and creative agents) and the feeling which feels (subject) is the process of concrescence. The actual entity has, so to speak, made up its mind out of the data presented to it, and is now about to act as creative agent itself. The completion of the period of one electronic vibration initiates the next.

In such a case as this, each actual entity will re-enact the character of the preceding one, for (i) the subjective aim and form of the nascent actual entity is determined by its space-time contiguity to the immediately preceding electronic actual entity, or occasion, (ii) the overwhelmingly most important physical feelings of its initial phase are the objectified feelings of this preceding electronic occasion, (iii) consequently, the eternal object of the conceptual feeling is the same as in the previous occasion, and also appropriate to the fulfilment of its subjective aim.

Enduring objects

The sequence of such electronic occasions together form the *enduring object* which we call "an" electron, and this will persist until some other actual entity—say, some energy wave—enters into the initial data in such a way as to alter the character of the objective datum.

In the case of more complex actual entities, such as those in living organisms, the physical and conceptual feelings available for the concrescence are much more complex. Before considering the life history of such an actual entity, however, we must consider more closely a number of conceptions which are essential to Whitehead's philosophy.

Objective immortality

With the achievement of the final determinate feeling—the satisfaction—the life history of an actual entity is over, for its subjective aim, or final cause, no longer operates. It perishes, but has *objective immortality*, in that it enters into, and is a determinant of, other actual entities. Indeed, it is cardinal to Whiteheads' philosophy that the subjective aim of an actual entity is not merely at self-realization, but at self-realization as an agent creative of other entities like itself, or at least of the production in other actual entities of feelings like its own. Satisfaction has a *superjective* character, in its function as a determinant of other entities like itself. Whitehead speaks of this superjective character as *physical purpose* (*P.R.*, 392).

Creative emphasis, or causal efficacy, is dependent upon unity or order in the creative agent. It is therefore basic to the nature of actual entities that their subjective aim is to unify the multiplicity of their physical and conceptual feelings into a single feeling. But even in the case of a completed actual entity, though its satisfaction is defined as "one complex fully determinate feeling" (*P.R.*, 35), yet when this satisfaction is objectified as datum for a succeeding entity, it is divisible, as we have seen, into its component feelings (felt by the new entity as physical feelings). "By reason of this 'divisible' character causation is the transfer of a feeling, not of a total satisfaction" (*P.R.*, 337) and again (p. 334) he states that the objective datum is a concrescence of feelings *entertained* by the actual entities which are the initial data.

Physical and mental poles

Physical feelings are the *physical pole*, and conceptual feelings the *mental pole* of the actual entity. The latter term does not, however imply consciousness, which is characteristic of only a very limited class of actual entities. Every actual entity is dipolar in this sense, though the relative importance of the two poles differs in different entities. In the simple inanimate type of actual entity which we have been considering so far, the mental pole is negligible, for there are no conceptual feelings of eternal objects beyond those dominant in the objective datum. The electronic occasion does not have to choose between possible modes of reaction to its physical feelings, because only one is presented to it.

Hence, as we have seen, such actual entities merely reproduce the character of that portion of the initial data which was dominant in their own prehensions. "Physical endurance is the process of continuously inheriting a certain identity of character transmitted through a historical route of events" (*S.M.W.*, 159). A molecule is an enduring object in this sense, containing subsidiary strands of enduring objects (atoms), and these again further subsidiary strands, the electrons and protons. A light wave is an enduring object, the actual occasions of which are the single vibrations. Some kinds of enduring objects form material bodies, others do not (*P.R.*, 152). The continuity of human personality, of a lump of rock, and of an electron are all of the same nature. They are all enduring objects, their continuity being due to the inheritance of subjective aim and form by each actual entity from its predecessor. "Our consciousness of the self-identity pervading our life-thread of occasions is nothing other than knowledge of a special strand of unity within the general unity of nature" (*A.I.*, 241). It is an exhibition of the object-to-subject structure of experience. It can be otherwise stated as the vector structure of nature.

Some enduring objects—such as living organisms—endure, not through mere reenactment of character from actual entity to actual entity, but by originative response, adapting the organism to changes in the environment. The mental pole is more in evidence, there is more elaborate derivation of conceptual feelings, with selective concrescence. The case of living organisms is dealt with more fully below.

The word *event* (*P.R.*, 101) used above needs explanation. An actual entity is an atomic event; the word can be used also to express any group of entities (nexus) exhibiting a certain coherence—e.g., an electron, a tree, a cricket-match. In fact, the words nexus and event may signify the same thing.

The word *nexus* expresses the "togetherness" of atomic parts. A molecule, for instance, is a nexus of atoms. Indeed, the whole universe is in one sense a nexus. Further consideration of the conception of nexus will be taken up below.

THE EXTENSIVE CONTINUUM

We now come to the general scheme of relatedness by which the prehensions of any one actual entity are bound together into a unity, (the process of concrescence) or by which entities are bound into nexūs (*P.R.*, 408).

Eternal objects are *all* the possible ways in which entities or nexūs could enter into the constitution of other entities. But not all possible ways are realizable in our own cosmic epoch. What is possible is determined by the general scheme of relatedness which obtains in our universe. This general scheme of relatedness Whitehead calls the *extensive continuum*. The character of the extensive continuum therefore imposes a limitation on possibilities of realization of eternal objects. Other cosmic epochs, with different extensive continua, would contain things exhibiting qualities and characteristics impossible in our own. For this reason Whitehead speaks of eternal objects as *pure potentials* and the extensive continuum as a *real potential*.

The most obvious feature of our own extensive continuum is its space-time character—the space-time continuum, but it has a more fundamental character than that, and includes more fundamental kinds of relatedness. "According to the philosophy of organism, the extensive space-time continuum is the fundamental aspect of the limitation laid upon abstract potentiality by the actual world. A more complete rendering of this limited 'real' potentiality is the 'physical field' " (*P.R.*, 111).

At this stage I will introduce a diagram, with apologies to Professor Whitehead for such a naïve attempt to convey the writer's notion of this part of his system. The diagram is intended merely as an aid to verbal description of the notion of the extensive continuum, (so far as its space-time quality is concerned) with contained actual entities. It obviously must not be taken as representing a model. In the diagram, three-dimensional space is represented by the two-dimensional horizontal plane, while the vertical dimension represents time, the temporal succession reading upwards. The outline of the whole figure, before the columns inside it were erected, represents the extensive continuum in its merely potential aspect—divisible, but not yet divided.

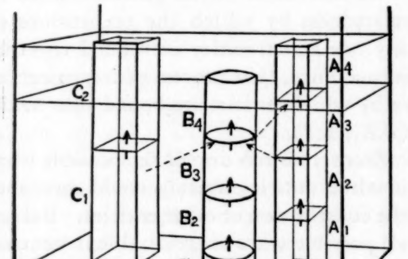

Fig. 1. For Explanation See Text

The three columns, *A*, *B*, *C*, each represent an enduring object, each compartment (A_1, A_2, etc.) being an actual entity. Only the uppermost entity of each column would be in existence at the moment. Each of these enduring objects consists of a single strand of entities. Such simple enduring objects are rarely found in nature. Even an electron probably consists of several strands. An atom certainly contains many such strands (electrons, protons). But for sake of an example we can visualize *A*, *B* and *C* each as objects at the limit of simplicity of physical objects. They might also represent elements in trains of conscious thought—a reminder that the diagram is as purely symbolic as words.

The spatial dimension (any horizontal plane in the whole solid) is atomized by the actual entities. The situation of the cross-section of a column in the cross-section of the whole solid represents the position of the actual entity in space at that instant of time. The unoccupied spaces between the columns represent "empty space."

The time dimension is atomized into "epochs" or durations by the horizontal partitions between the actual entities of each column. The vertical extent of A_2, for instance, represents the duration of the entity A_2. The succession of durations constitutes the progress of time. Whitehead's views as to the nature of the subdivisions within a duration are not essential for present purposes.

The arrows in the diagram represent objectifications of feelings of antecedent actual entities in succeeding actual entities. For the sake of clarity in the diagram, the enduring objects are shown separated from each other, and therefore the arrows connecting actual entities of different enduring objects have to cross intervals of empty space ("action at a distance"). Whether this kind of action actually occurs or not, it is clear that the physical prehensions known to science—i.e. transmission of energy—do not normally take place in this way. An object influences another object that is not in direct contact with it either through intermediate contiguous material objects, or by means of a wave of energy passing from one object to the other. In the latter case the influence of the object emitting a ray of light is transmitted to the object receiving it by inheritance from occasion to occasion (the individual undulations) in the ray of light. Whitehead points out that it is not necessary for his philosophy to deny that there is direct objectification of one occasion in another which is not contiguous with it. He suggests that telepathy would illustrate this latter type of objectification (*P.R.*, 435–6).

The provision of empty spaces between the enduring objects oversimplifies the situation in another way, since in nature there will normally be a group of antecedent actual entities, not merely a single one, contiguous with the new actual entity and constituting its initial data.

The temporal durations, the succession of which constitute time, are of very unequal extent. As shown in the figure, the durations of *C* are twice as long as those of *A* and *B*. *A* and *B* have durations of the same extent, but they are out of phase. The duration of an actual entity (vibratory period) in some forms of energy may be only a billionth of a second. Those constituting the stream of human consciousness (the "specious present") have much more extensive durations. Whitehead apparently allots them the limits of about $\frac{1}{10}$ to $\frac{1}{2}$ a second (*A.I.*, 233). Many psychologists, however, allow much wider limits. God is also an actual entity, whose duration includes the whole of time.

Events are contemporary when they arise in causal independence of each other —when, for instance, having regard to the finite velocity of light, there has not been time for causal effect to be transmitted through the chain of intervening entities.

The diagram is greatly simplified by the fact that the three enduring objects are at rest with reference to one another. Actual entities themselves do not move in space any more than in time. Motion refers to the enduring object as a whole, and concerns the spatio-temporal relations of succeeding to preceding entity.

Let us now return to the life history of an actual entity. The entity begins as an atomization of the extensive continuum, by which regional standpoints are provided for the new generation of actual entities. The factor which brings about this atomization is creativity. The character of creativity is described by Emmet as follows (p. 73) . . . . "it is the urge towards differentiation and unification, i.e. towards the individuation of itself into many actualities, which are called its 'creatures,' and towards the growing together of these creatures into new unities." Whitehead says "Thus God's purpose in the creative advance is the evocation of intensities" (*P.R.*, 147)—and degree of intensity is proportional to degree of coherence, or of order in unification.

The mode in which the atomization takes place depends upon the relations in the extensive continuum of the actual entities which have just completed themselves. Thus, in the diagram, the satisfaction of A_3 determines that the supervening atomization of the extensive continuum will include a regional standpoint A_4 contiguous to A_3.

Subjective form

Perhaps the simplest way of describing the actual entity at the moment of its differentiation out of the general creativity is as a feeling with an aim at greater intensity of feeling. The particular intensity or satisfaction which this entity aims at (its subjective aim) depends upon its location in the extensive continuum and also determines what aspects of the initial data will be objectified in the actual entity as its objective datum.

It is tempting to try to illustrate the notion of the subjective aim and form of a simple nascent actual entity arising in conformity with those of its principal predecessor, by reference to the diagram. The absurdity of trying to explain such an idea pictorially, as well as the play on the word "form," is too obvious for the attempt to be misleading. But let us consider the enduring objects, *A* and *B* in the figure. They will be continued by A_5 and B_5. One can picture A_5 and B_5 at the moment of their atomization out of the extensive continuum as having the "form" of a cube and a cylinder respectively, but as yet empty of content. The conformity of the shapes of the new entities with those of their predecessors represents the conformity of the subjective aims, and therefore the subjective form of the feelings by which the forms will be filled in the process of concrescence. "The Subjective Form is the feeling of the subject, derived from its objects, and re-directed upon them" (Emmet, 160). In the simpler types of actual entities, the "form" will be "filled" automatically, for the same factors that determine the subjective aim will also supply the appropriate data for its satisfaction. But in more complex cases—especially, as we shall see, in living actual entities—this is not necessarily the case. The entity may have to manipulate its data (by selection of eternal objects gaining ingression into the actual entity), or the data received may cause the actual entity to modify its subjective aim and form.

Although the subjective aim is given at the moment of birth of the actual entity, nevertheless the entity has autonomy in the modification of its initial subjective aim (*P.R.*, 347) and again, Whitehead talks about conceptual prehensions adjusting and readjusting subjective forms. "The subject completes itself during the process of concrescence by a self criticism of its own incomplete phases" (*P.R.*, 345).

Efficient and final causation

The objectification of aspects of the preceding actual world in each entity is felt by that entity as physical feelings. In the language of causation, physical feelings are efficient causation. "Efficient causation expresses the transition from actual entity to actual entity" (*P.R.*, 209). "The physical theory of the structural flow of energy has to do with the transmission of simple physical feelings from individual actuality to individual actuality" (*P.R.*, 360). Or, quoting Emmet (p. 142), "So 'causation' becomes the reproduction in one actual occasion of the feelings of another, or, more precisely, the conformity of the feelings of the present occasion to the feelings of others."

On the other hand, subjective aim is *final causation*. "Concrescence moves towards its final cause, which is its subjective aim" (*P.R.*, 298).

It appears, therefore, that in Whitehead's system causation has the "anthropomorphic" sense of agency. This is the consequence of his resolute application of the principle that man is part of the order of nature, and therefore that one must not look in nature for an order different in principle from what one finds exemplified in man. Not only final causation, but also efficient causation is ultimately referable to an agent, for the subjective aim (final causation) of an actual entity is not merely at self-completion, but at self-realization as a creative agent, which is accomplished through its efficient causation of other actual entities.

A COMPLEX ACTUAL ENTITY

Now let us consider the life history of a more complex actual entity—such as those constituting vital processes in living organisms (metabolism, etc.) and, above all, actual entities in the brain having the conscious form.

Firstly, consider again, by way of contrast, certain features of simple actual entities.

> The simplest grade of actual occasions must be conceived as experiencing a few sensa, with the minimum of patterned contrast. The sensa are then experienced emotionally, and constitute the specific feelings whose intensities sum up into the unity of satisfaction. In such occasions the process is deficient in its highest phases; the process is the slave to the datum. There is the individualizing phase of conformal feeling, but the originative phases of supplementary and conceptual feelings, are negligible (*P.R.*, 162—sensa are eternal objects, *P.R.*, 160).

Again, in inorganic actual occasions "the influx of objectifications of the actualities of the world as organized vehicles of feeling is responded to by a mere subjective appropriation of such elements of feeling in their received relevance" (*P.R.*, 249).

In the more complex entities the mental pole is more active—there is a richer derivation of conceptual feelings (Category of Conceptual Reversion), and a more selective concrescence.

It will be easiest to take as our example of such a complex entity, a conscious actual entity (occasion) in the human brain. Consider for instance, the perception of an object, say a fruit. First, the fruit, together with its surroundings, is prehended by the actual occasions constituting the retina of the eye at the moment, in the form of feelings inherited from occasion to occasion constituting the periods of the light waves reaching the eye from the object. The feelings in the actual occasions in the retina are transmitted from occasion to occasion up the optic nerve to the percipient actual occasion in the brain. This actual occasion therefore prehends the preceding bodily occasions in the optic nerve—a constituent of which was the pattern or nexus of feelings originally constituted as the nexus of light waves passing from the fruit to the retina. Thus the fruit is perceived (prehended) by the brain occasion.

(This account omits all mention of Whitehead's notion of the two modes of perception—the mode of causal efficacy and the mode of presentational immediacy—and of symbolic reference. This is set out in *Process and Reality*, but more satisfactorily in *Symbolism: Its Meaning and Effect* (1928)).

So far, little beyond the "responsive phase" has been exhibited by this brain occasion. But now, in a high-grade conscious occasion there would be further activity of its mental pole. In the first instance, the eternal object correlated with the physical feelings of the fruit objectified in the percipient occasion will be a patch of color of a certain shape (a sensum). There will then be a secondary derivation of conceptual feelings from the primary one—such as the ideas of ripeness, edibility, etc. The subjective form of these conceptual feelings has the character of a valuation of the eternal objects—i.e. their value for the realization of the subjective aim of the actual occasion. (The sensum, and the characterization of the subjective form of the conceptual feelings, involve the distinction between the objective and subjective species of eternal objects. *P.R.*, 412.)

"The intermediate phase of self formation" (between the initial phase of reception of the past and the final stage of anticipation of the future) "is a ferment of qualitative valuation" (*A.I.*, 269). It constitutes the supplemental phase mentioned earlier.

These feelings are successively unified by concrescence into the satisfaction of the subjective aim—which in this case is concerned with maintaining the well-being of the organism. This satisfaction (or rather, certain of its component feelings) is objectified into the actual occasions constituting the motor centers of the brain, resulting in the seizing and eating of the fruit. (This example of perception is the present writer's.)

Originality of response

In the case we have just described the feelings prehended by the percipient occasion in the brain included a mass of feelings such as those appearing physically as the metabolic processes in the optic nerve, etc. as well as those more particularly inherited from the nexus of light waves leaving the fruit. But the high grade living occasion which we are now considering can analyse this mass of data and concentrate, so to speak, on a particular constituent of it—namely, the visual sensum in its relation to its surrounding world. Hence the living organism can respond to individual components of a complex objective datum in a way in which an electron cannot.

Originality of response involves this bringing into definiteness of feelings which were vague in the initial phase of the concrescence. "By the originative power of the supplemental phase, what was vague, ill defined, and hardly relevant in causal efficacy, becomes distinct, well defined, and importantly relevant in presentational immediacy" (*P.R.*, 242). By bringing into prominence (paying attention to) physical and conceptual feelings, a richer influx of conceptual feelings ensues, from which a selective concrescence takes place, the selection being the selection of the eternal objects which are relevant to the concrescence which is to satisfy the subjective aim (*P.R.*, 214). "A single occasion is alive when the subjective aim which determines its process of concrescence has introduced a novelty of definiteness not to be found in the inherited data of its primary phase" (*P.R.*, 145).

It will be noted that originality of response is limited in two ways. Firstly, the total kinds of eternal objects are given for the universe, and therefore the *possible* conceptual feelings are limited in this way. "There are no novel eternal objects" (*P.R.*, 30). (This does not mean, of course, that all possible modes of feeling have yet been realized in the world.) Secondly, conceptual feelings are derived from, relevant to, the physical feelings, either immediately, or mediately through other conceptual feelings. Ideas cannot gain ingress to the mind absolutely out of the blue. They must be suggested by feelings or ideas already present.

The notion of *relevance* is thus seen to be fundamental for Whitehead's conception of the appearance of novelty, but to attempt to expound it would be beyond the scope of this brief account. It is set out in Chapter III of *Process and Reality*. Briefly, however, relevance—in other words a mutual order among eternal objects—has to be accepted as the given condition under which creativity is able to produce an ordered world with evolutionary advance into novelty.

This selection of eternal objects takes place (at least potentially) in all actual entities. It is part of the way in which the subjective aim (final cause) expresses itself. But in non-living entities, the component conceptual feelings from which a selection can be made are so few and obvious that there is virtually no freedom of selection, and therefore simple re-enactment of the concrescence of the preceding actual entity takes place, as described above.

NEXUS

Leaving now the life history of an actual entity, we must consider the conception of *nexus* a little more closely. A nexus is defined by Whitehead as "a set of actual entities in the unity of the relatedness constituted by their prehensions of each other" (Category of Explanation, XIV, *P.R.*, 32).

The simplest type of nexus is constituted by a single "route" or "strand"—that is to say, temporal succession—of actual entities—e.g. $A_1 - A_4$ in the diagram. Now take any particular entity, A_4. A_4 prehends A_3. But A_3 prehended A_2, therefore in prehending A_3, A_4 also prehends A_3's prehension of A_2. This process can be continued back indefinitely. So it comes to pass that in prehending A_3, A_4 is prehending the whole of the preceding actual entities of the strand, as a unity. Any enduring object is thus necessarily a nexus.

Now consider a nexus containing two such strands, *A* and *B*, using the letters, without subscripts, to apply to the strands composed by A_1, A_2, A_3, etc. It might be helpful to exemplify these strands as chemical atoms (remembering that actually an atom consists of many strands—e.g. electrons and protons). When *A* and *B* are brought into the proper relations (concerning emphasis of mutual prehension) they unite into the nexus known as a molecule. In other words, the conceptual feeling derivate from the prehension of *A* and *B* in one datum is the feeling of the eternal object, molecule of *AB*. Now we will suppose that A_5 and B_5 come into that relation. These are succeeded by A_6 and B_6. A_6 prehends A_5 and B_5 as initial data which undergo concrescence into this single objective datum. The prehension by B_6 of B_5 and A_5 is of a corresponding nature.

It follows that every nexus is accomplished for the first time during the concrescence of an actual entity (*P.R.*, 325). It is a concrescence of separate feelings into a unity. But once accomplished, it can in future be objectified as a unity in other actual entities. The act of combination of the two atoms into the molecule is the original formation of the nexus. But in future the nexus can be objectified as such, the objectification appearing physically as the properties of the molecule.

It is in this conception of the unity of a nexus that we strike the main idea of theories of organism as usually understood by biologists, namely, the idea that the whole is more than the sum of its parts, and indeed imposes its own character on its parts. As Ritter puts it, the whole acts causally on its parts, as well as being acted on causally by its parts.

This is only understandable if we get away from the idea of substance and fix our attention on process. We must not think of the molecule as composed of ultimate particles of matter in motion. But the molecule is a pattern of processes, and each constituent process conforms to its place in the pattern, and resists factors tending to alter it. This conformity is, in Whitehead's terminology, conformity of the subjective aim and form of each actual entity to the pattern of feelings provided for it by other members of the nexus (as prehended from its own perspective). Its resistance to alteration of the nexus is the objectification of its own feelings as determinant agents in the other actual entities of the nexus. As Whitehead says in a much quoted passage (*S.M.W.*, 116), "An electron within a living body is different from an electron outside it, by reason of the plan of the body."

Indeed, from one point of view Whitehead's philosophy may be characterised as showing how things (nexūs) have subjective multiplicity and objective unity. The number of actual entities composing the complex nexus known as a dog is colossal. Yet the rabbit perceives the dog, not as a collection of separate entities, but as a dog. And it must be remembered that this perception, or prehension, of the nexus as a unity is not confined to external actual entities. But the actual entities composing the nexus itself prehend the other entities in the nexus not as individuals, but as a unity, in which of course the component parts have not necessarily lost their identity.

Whitehead's thesis that all actual entities prehend all other actual entities either directly, or through the mediation of other actual entities means that the whole Universe is a nexus. "If we allow for degrees of relevance, and for negligible relevance, we must say that every actual entity is present in every other actual entity" (*P.R.*, 69). But there appears to be nothing in his basic conception of the nature of actual entities which necessitates the formation of subordinate nexūs within the universal nexus. Whitehead calls his philosophy a Philosophy of Organism. There appears, however, to be nothing in the nature of reality as he conceives it which necessarily leads to the formation of organisms in the plural—i.e. of the things we are acquainted with. It is a peculiarity of the extensive continuum of our own universe and epoch that leads to certain types of actual entities having certain special relations to each other, and so producing electrons, molecules, rocks and men. A universe of actual entities of the same metaphysical nature as our own seems to be conceivable in which no nexūs within the universal nexus were formed. Such a universe would presumably possess a uniform and unchanging texture throughout.

Societies

Whitehead recognizes several types of nexūs. In one sense, as we have seen, the whole universe is a nexus. But there are others of a more intimate type. Such are called "societies". In a society the internal relations are so close that it is relatively independent of the rest of the world—that is to say, of its environment. It is worth while quoting Whitehead's description of a society, and certain other nexūs.

> A nexus enjoys "social order" where (i) there is a common element of form illustrated in the definiteness of each of its included actual entities, and (ii) this common element of form arises in each member of the nexus by reason of the conditions imposed upon it by its prehensions of some other members of the nexus, and (iii) these prehensions impose that condition of reproduction by reason of their inclusion of positive feelings of that common form. Such a nexus is called a "society," and the common form is the "defining characteristic" of the society. . . . . The common element of form is simply a complex eternal object exemplified in each member of the nexus (*P.R.*, 46).
>
> A nexus enjoys "personal order" when (α) it is a "society," and (β) when the genetic relatedness of its members orders these members "serially". . . . . Such a nexus is called an 'enduring object' (*P.R.*, 47).

For example, the strands *A*, *B*, *C* in the diagram each have personal order.

It would appear that any society which endures (i.e. lasts beyond the life history of a single set of contemporary entities) must have a certain degree of personal order.

"An ordinary physical object, which has temporal endurance, is a society. In the ideally simple case, it has personal order and is an 'enduring object'. A society may (or may not) be analysable into many strands of 'enduring objects'. This will be the case for most ordinary physical objects" (*P.R.*, 47). Such nexūs, analysable into strands, are "corpuscular societies" (*P.R.*, 48).

A structured society (*P.R.*, 137) is a society containing (1) subordinate societies, and (2) subordinate nexūs of a lower type than societies. Such a structured society is illustrated by a living cell, in which

(1) the subordinate societies are nexūs which could have retained their dominant features in the general environment which is the universal nexus, apart from the special environment of the structured society of which they form a part.

(2) the subordinate nexūs are nexūs which present no features capable of sustaining themselves apart from the special environment provided by that structured society.

Subordinate societies are the inorganic nexūs within the living cell—for instance, a molecule. Subordinate nexūs are "entirely living" (*P.R.*, 143). Thus life does not pertain to the cell as a whole, but to subordinate nexūs within it.

Physical Physiology, according to Whitehead, deals with subordinate societies—i.e. the subservient inorganic apparatus.

Psychological Physiology seeks to deal with the "entirely living" nexūs, partly in abstraction from the inorganic apparatus, partly in respect to their response to the inorganic apparatus, and partly in regard to their responses to each other (*P.R.*, 144).

LIFE

Whitehead's conception of *life* may conveniently be considered here. A living organism is always a nexus of the grade of a society, containing both subordinate societies and subordinate nexūs, as we have just seen. Life is characteristic of one or more of these subordinate nexūs. In the case of the higher organisms—for instance, the vertebrates—one of these subordinate nexūs has a peculiarly dominant function. The mind of man, for instance, is such a dominant subordinate nexus. It has personal order, for it is an enduring object, exhibiting memory and personal identity. The stream of actual occasions of which it is composed are called *presiding occasions*. Thus he says (*P. R.*, 152).

> In a living body of a high type there are grades of occasions so co-ordinated by their paths of inheritance through the body, that a peculiar richness of inheritance is enjoyed by various occasions in some parts of the body. Finally, the brain is co-ordinated so that a peculiar richness of inheritance is enjoyed now by this and now by that part; and thus there is produced the presiding personality [referred to below as the presiding occasion] at that moment in the body. Owing to the delicate organization of the body, there is a returned influence, an inheritance of character derived from the presiding occasion and modifying the subsequent occasions through the rest of the body.

The endurance of mind is achieved in the same way as that of any other "enduring object"—namely by inheritance from one actual entity (presiding occasion) to another.

Whitehead locates the living occasions in the "empty spaces" of cells (*P.R.*, 138) or even "wandering in 'empty space' amid the interstices of the brain" (*P.R.*, 481). It would appear that his reason for this disconcerting suggestion is consideration of the originality of response characteristic of living occasions. It appears that by empty space he does not mean space unoccupied by actual entities, but unoccupied by any corpuscular society. An actual entity arising in contiguity with such a society is overwhelmingly constrained into conformity with its objectifications. But arising in space which is not so occupied, it will not be thus dominated and so will have greater freedom of action. This at any rate is what the writer conceives to be the meaning of *P.R.*, 147.

The lower forms of animal life, and all vegetable life, according to Whitehead show no evidence of the dominance of any included personal society (*A.I.*, 264)—i.e. of an enduring stream of presiding occasions. Rather, their life has the form of a democracy of living subordinate nexūs (together, of course, with subordinate societies providing the subservient inorganic apparatus), which, unlike the case of the higher animals, are not dominated by presiding occasions.

As regards the character of the actual entities themselves which may be called living, or components of a living society, we note first that in *Process and Reality* life is ascribed to single actual entities, while in *Adventures of Ideas* it is ascribed to groups of coördinated actual entities.

> A single occasion is alive when the subjective aim which determines its process of concrescence has introduced a novelty of definiteness not to be found in the inherited data of its primary phase (*P.R.*, 145).
>
> Those activities in the self-formation of actual occasions which, if coördinated, yield living societies are the intermediate mental functionings transforming the initial phase of reception into the final phase of anticipation [in *P.R.* called satisfaction—see *A.I.*, 248]. In so far as the mental spontaneities of occasion do not thwart each other, but are directed to a common objective amid varying circumstances, there is life. . . . . It is evident that according to this definition no single occasion can be called living (*A.I.*, 266).

The actual entity itself, whether we call each one living, or only a component of a living group of entities, is characterised by enhanced activity of the mental pole, whereby there is a richer development of conceptual feelings of eternal objects, some of which may be novel in the sense that they are not in the original objective datum. From these eternal objects a selection is made of those appropriate to the fulfilment of its subjective aim. In all actual entities there is, as we have seen, a mental pole, and conceptual feeling of eternal objects, with potential power of selection (positive or negative prehension)—but this is of negligible force (at any rate in the average of the huge numbers of actual entities composing even the smallest of observable inorganic bodies or events), and therefore simple re-enaction of the process of the preceding actual entity which is dominant in the initial data takes place. Endurance of inorganic objects is brought about thus, but continues only so long as the initial data are repeated at least in their dominant features for each successive generation of actual entities. Should this change, the changed prehensions of the succeeding actual entity will result in a corresponding change in the concrescence —and the molecule, for instance, is decomposed.

Living organisms, however, can achieve endurance, not merely by re-enactment, but in face of changed environment (initial data) by virtue of this greater power of conceptual feelings for eternal objects not to be found in the initial data, with selection among them. Thus living organisms adapt themselves to their environment by originative action.

It is important to realize that Whitehead does not consider that a nexus of actual entities can itself be considered as an actual entity of a higher order with a subjective aim of its own.

Commenting on this, Emmet remarks (p. 184):

> Are not all these descriptions of the kinds of prehensions involved in a concrescence applicable rather to the nexus of actual entities as a whole, taken over a long spell of its history? We can with some plausibility talk of an animal as having a subjective aim; but can we seriously use the same language of an "electronic occasion"?

Presiding occasions

As we have seen, in one sense a higher animal can be said to have a subjective aim transcending the subjective aims of all its component actual entities, for its behavior is governed by a "presiding occasion"—or if the mind is not merely a momentary flash, a route of presiding occasions with "inheritance from presiding occasion to presiding occasion." This seems at first sight reminiscent of the vitalistic view of the body as a machine controlled by the mind as mechanic, and Whitehead's theory as applied to the behavior of the higher organisms seems to become less a theory of organism in the usual sense of the term, than a theory of the manner in which information is conveyed from the body to the mind, and instructions conveyed back again from the mind to the body. But there is actually this fundamental difference from the older point of view, that the body-mind relation involved is not an *ad hoc* hypothesis, but an illustration of the nature of actual entities and of the relation between them which is universal throughout nature.

As we have seen, however, this conception of presiding occasions is not essential to Whitehead's conception of the unity or wholeness of an organism, whether living or not living. It is indeed only the limiting case, for this wholeness is always brought about by the prehensions and objectifications of the component actual entities, certain classes of which may be more important in this regard than others. The special dominance of the presiding occasions constituting the mind of a higher animal can be connected by grades with the case of a simple chemical molecule where the task is presumably more equally shared by all the component actual entities. The case of the life (apart from conscious mental life) of a multicellular organism occupies an intermediate position, for he considers that there is no life of the organism as a whole above that of its individual cells. Within each cell certain subordinate nexūs are dominant in preserving the cell as a living organism. The organism as a whole is presumably to be conceived as compounded out of its living cells on the same principle as any other nexus. Each cell (through the agency of the actual entities in its living subordinate nexūs) lives its own life in conformity with its environment (by its prehensions of the rest of the nexūs) and has its own "end-in-view," which is essentially to provide by its objectifications an environment for the other cells of the organism such that they in turn, while living *their* own lives will at the same time continue to provide an environment suitable for the continuance of the life of the cell in question.

SUMMARY

The features in Whitehead's system which will probably appear of most immediate significance to theoretical biology may now be enumerated.

1. Reality consists in experience or feeling, rather than in substance supporting qualities. This has fundamental consequences for the problem of the body-mind relation, which has always stood like a lion in the path of the biologist who is trying to form a conception of the living organism.

2. The process of experience is atomic, and yet of a nature to lead to a universal relatedness between the atoms of process (actual entities) under the guise of the objectification of preceding in succeeding actual entities. This is efficient causation.

3. Final causation (subjective aim) operates within each actual entity. Herein

lies the teleology of the universe (cf. *A.I.*, 249).

4. Since the subjective aim of an actual entity is not merely at self-completion, but at self-realization as an agent determinant of other actual entities, it follows that efficient causation is referable to the final causation of an agent.

5. Organisms, whether living or not, are nexūs. The general notion of nexūs is implied in the notions of prehension and concrescence—that is to say, in the nature of an actual entity itself. An account of the various types of nexūs actually found in nature is given above.

6. The difference between living and non-living organisms is one of degree only. All actual entities have a measure of autonomy in their self-realization out of their data, but this factor is of negligible importance in the case of non-living entities owing to the simplicity of the subjective aim and objective datum, which give little scope for selection among the conceptual feelings of the relevant eternal objects.

THE FUNCTIONS OF THE PYRAMIDAL TRACTS

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IN SPITE of the fact that the term "pyramidal tract" is commonly used in neurology, a certain confusion seems to exist as to its proper definition. Thus some define it as all those fibers passing downwards through the pyramids of the medulla to the spinal cord, or as the sum total of all cortico-spinal fibers. Others define it as consisting of only those cortico-spinal fibers arising from a certain region in the cerebral cortex, such as the primary motor cortex or area 4 of Brodmann. By the last definition any cortico-spinal fibers passing from the premotor area (area 6 of Brodmann) or from the postcentral gyrus would be regarded as "extra-pyramidal."

On historical grounds the priority goes to the first definition, for the name arose not as many suppose, because the tract arises from pyramidal cells in the cerebral cortex, but because it represents a continuation of the pyramids of the medulla. The name was given, indeed, before any connection of the tract with the cerebral cortex was established. Türck (1851, 1853) who first described it, gave the name "pyramidal-lateral-column-tract" for what is now known as the crossed pyramidal tract, and the name "capsular-anterior-column-tract," to what is now called the direct pyramidal tract or the tract of Türck. He regarded these two as descending tracts which arose in the region of the basal ganglia, particularly in the lenticular nucleus. Flechsig in 1876 described both components under the name "pyramidal tract." He agreed with Türck as to its probable lenticular origin, but since he could not be certain of possible cortical connections he declined to use the term "lenticular-nucleus-lateral-column-tract" which he otherwise preferred. It was not till a later date (1877, 1881) that Flechsig brilliantly demonstrated by the myelogenetic method the connections of the pyramidal system with the cerebral cortex, particularly the precentral gyrus and the paracentral lobule.

The experimental anatomists following Flechsig agree in defining the pyramidal system as those fibers passing through the pyramids into the spinal cord or as the sum total of the corticospinal system. Agreement has not been reached, however, as to the extent of its origin from the cerebral cortex. Campbell ('05) on the basis of his studies on amyotrophic lateral sclerosis (which were later proved to be incorrect) and some other evidence, affirmed that the tract arose exclusively from the giant cells of Betz within the cytoarchitecturally defined motor area.

The term "motor area" or "motor cortex" is an unsatisfactory one, since four definitions have been given it as follows: (1) A specific cytoarchitectural cortical area, such as area 4 of Brodmann, or area FA of Economo; (2) the area of origin of the pyramidal tract; (3) the electrically excitable area of the cortex; (4) that cortical area which when removed will give the maximal paralysis. In the present discussion the first definition is consistently used.

Holmes and May ('09) from their studies of chromatolytic cell changes following spinal cord lesions in a large variety of experimental animals and in human cases, reached the same conclusions as Campbell. The majority of investigators, on the other hand, have described pyramidal fibers arising from a larger cortical region than the cytoarchitecturally determined motor area or Brodmann's area 4. Thus Flechsig's ('05, '20) myelogenetic area from which the pyramidal tract is stated to arise passes forward on to the premotor area or Brodmann's area 6; and O. Vogt ('06) describes a few pyramidal fibers arising from the post central gyrus. Dejerine ('01), Monakow ('05, '14) and Minkowski ('23–'24) describe pyramidal fibers descending from both the premotor and post-rolandic areas following cerebral cortex lesions. Schröder ('14) found, in contrast to Holmes and May, that spinal cord lesions produced retrograde changes in other than the Betz cells and that they extended into the pre-motor region. Economo and Koskinas ('25) conclude from various lines of evidence that the Betz cells are not the sole cells of origin of the pyramidal tract and that the area of origin is probably larger than cytoarchitectural motor area.

If we thus differentiate between the definition of the pyramidal tract and the conclusions reached regarding its origin, it readily becomes apparent that throughout the experimental literature the pyramidal tract is *defined* according to the first definition with which the discussion began. Any definition which would exclude cortico-spinal fibers, from say, the premotor area (area 6 of Brodmann), as "extrapyramidal," has no historical sanction and can be defended only on a purely arbitrary basis. In addition, the *conclusion*, that the tract in question arises solely from the cytoarchitecturally defined motor area rests on a very insecure foundation.

EXPERIMENTAL LESIONS OF THE PYRAMIDAL TRACTS

Experimental lesions of the pyramidal tracts free from associated damage to other descending motor systems can be made only by attacking them in the pyramids of the medulla. Lesions of the cytoarchitecturally defined motor cortex are unsatisfactory for this purpose for several reasons. The unavoidable associated injury to the sensory and associational systems is obvious. In addition there descend from the motor area many other cortico-fugal fibers besides the pyramidal as Mellus ('95) long ago pointed out. This author stated that of the descending degeneration resulting from the removal of the thumb area in the monkey, as much as half or more stopped at the substantia nigra. There is also a significant motor area-rubral system as Rothmann ('01) and Marshall ('34 b) have shown. These fibers must of necessity be damaged with the pyramidal in motor area lesions. Finally, for reasons pointed out above, it has not been satisfactorily demonstrated that the removal of the motor area will cause a degeneration of the pyramidal system in its entirety.

Although the number of experimenters who have made lesions in the motor cortex is large, those who have attempted to interrupt the pyramidal tract in the medulla are relatively few. The first to produce experimental lesions in the pyramids—although he had no knowledge of the existence of the definitive pyramidal tracts—was Magendie (1838). He described the findings as follows:

> I divided directly one of the pyramidalia in two living animals, reaching it through the fourth ventricle. I could not remark any sensible lesion in the movements, particularly no paralysis ensued, either on the wounded or opposite side. I did more, I divided entirely and across, the two pyramidalia about the

middle of their length, and no apparent derangement in the motions followed. I observed only a little difficulty in walking forwards.

Some years later Schiff (1858) criticized Magendie's work on the grounds that cutting through the midline of the medulla from the fourth ventricle destroyed many other important structures besides the pyramids. He devised two operative approaches and cut, in rabbits, the pyramids, or the pyramidal decussation without splitting the medulla. He stated that as a result of his operations it has been shown "that neither a transitory nor a permanent noticeable paralysis necessarily follows, and that we are not entitled to endow the pyramid with the physiological properties of the anterolateral column, insofar as they are known at present." No anatomical evidence was offered by either Schiff or Magendie to show the extent of their lesions.

Of more recent date three different operative procedures have been used. These are (1) cutting the pyramids above the decussation from a ventral approach, either through a longitudinal incision in the neck (Starlinger, '95) or by the transphenoidal route (Ranson, '32); (2) cutting the pyramidal decussation through a ventral neck approach (Rothmann, '00); (3) cutting the pyramidal decussation by splitting the medulla sagittally in the midline from its dorsal surface (Magendie's operation). The first operation is obviously the method of choice, since the second and third must leave uncut the uncrossed pyramidal fibers in the lateral column of the cord. These fibers, now often forgotten, were long ago demonstrated in the dog by Muratoff ('93); in the monkey by Sherrington ('94), and in the cat by Boyce ('95). The third operation must in addition cut many other fibers. Even the first procedure, to be crucial, should be bilateral, for only by this method is it possible to remove completely all pyramidal innervation from even one side of the body.

PYRAMIDAL LESIONS IN THE DOG

The first anatomically controlled experiment on dogs, and indeed on any animal, was made by Starlinger ('95, '97). He cut both pyramids above the decussation in six animals and found initially a certain number of symptoms which gradually declined, leaving the animal in about two weeks essentially normal. Soon after the operation many of the animals could run and jump, although some are reported as being slower, more cautious, and more deliberate than normal. One is reported as jumping down heavily, another as showing marked postural defects such as crossing the forelegs, and a third as having rolling movements for a few days. Any motor weakness present was in general very slight, and spasticity did not appear. The symptomatology is reported as being less severe and of shorter duration than that following removal of the motor areas. Eventually there were found no symptoms which could be attributed to the absence of the pyramids. Histologically there was a degeneration of the pyramidal tracts more or less complete and traceable varying distances down the cord. In some cases there was damage to the medial lemniscus, the interolivary region and the median raphé.

Rothmann ('00, '01, '07) sectioned the pyramidal decussation from the ventral approach in a number of dogs. He found that a slight weakness and "ataxia" was initially present which, however, was practically over in two or three weeks. The "Berührungsreflexe" of Munk, reflexes of flexion and elevation of the limbs incited by stroking the hairs on the dorsum of the feet, were initially absent, but returned as a rule in four or five days.

Schüller ('06) made unilateral lesions in the pyramids in two dogs. There were relatively few symptoms. A tendency to inward rotation of the hip and shoulder was present, and when the animal was moved to one side or the other ("Flankengang") there was a slowness of movement in the affected limb, particularly in adduction. There was no spasticity. The "Berührungsreflexe" are reported as being more active on the affected side.

Finally Bechterew ('09) in his *Functionen der Nervencentra*, states that Protopopov has cut the pyramids on both sides with a gradual return of even isolated movements. The operative method is not given, nor is any histological proof of section provided.

PYRAMIDAL LESIONS IN THE CAT

The earliest reports of pyramidal lesions in the cat were made by Redlich ('97) and Probst ('01). Neither gives any anatomical or physiological details of his findings. Redlich says only that he has confirmed Starlinger's observations in the cat, and Probst states merely that destruction of the pyramidal tracts in the medulla brings about no fundamental disorders of motility. Of more recent date experiments on cats have been made by Langworthy ('28); Pike, Elsberg, McCulloch and Rizzolo ('29); Pike, Elsberg, McCulloch and Chappell ('30); Ranson ('32); and Marshall ('33, '34).

Langworthy ('28) cut the pyramidal decussation by a sagittal splitting of the medulla approached from the dorsal surface in nine cats. The results were severe, more so than in any of the cases previously reported. The foot pads were often turned under at the foot and ankle. No extensor tonus was present. The animals steadily improved with time. In general, they showed greater defects than those with the motor areas removed, a finding directly opposed to that of Starlinger, Rothmann and Redlich, and probably dependent upon the different operative procedure used. Histologically there were found injuries to the pyramidal tracts, the medial lemniscus and the olivary fibers.

Pike, Elsberg, McCulloch and Rizzolo ('29), and Pike, Elsberg, McCulloch and Chappell ('30) used the same operative approach as Langworthy. They found that "the immediate effects of splitting the decussation of the pyramids are manifested in a severe motor disability differing somewhat from that seen after bilateral ablation of the cortical motor areas. After motor area removal there is always extreme flaccidity of the muscles, while after this operation there may be occasional spasticity of the forelimbs." The rate of recovery is not clear from their reports. In one instance, it is said that "after 10 to 14 days the animal begins to walk about" and in another, "from 10 to 14 days after operation the animal again walks about fairly well." Eventually there was less disorder than that occurring from removal of the motor areas. Histologically, the pyramidal tracts were found degenerated.

Ranson ('32) cut one pyramid by the transphenoidal route in eleven cats. The animals were allowed to live only one day and hence no recovery phenomena are available. Shortly after the operation "all but one were able to walk and most of them walked very well." None showed signs of hypertonus in walking but when suspended in a sling, a certain degree of rigidity was apparent, which was greater in the fore than in the hind limb. This finding of increased extensor tone is in agreement with an observation of Ranson, Muir and Zeiss ('32) who found, in one animal, that a lesion in the spinal cord which partly severed the cortico-spinal tract and did not damage the rubro-spinal fibers produced a definite spasticity in the affected limbs.

Marshall ('33, '34) made twelve bilateral and five unilateral lesions in the pyramids after the method of Starlinger. Severe disorders of motility were absent except in a few animals, and in these they were confined to the first two days. There were, however, a number of initial defects, which gradually disappeared, partly or entirely, during the two or three weeks the animals were allowed to live. The initial defects included the following. There was an occasional transient staggering and a spontaneous placing of the feet in abnormal positions. Abnormal postures imposed upon the animal were not promptly corrected. There was a tendency towards a slight stiffness in the gait and under certain conditions, e.g., when suspended in a sling, a definite increased resistance to passive flexion (extensor tonus) was present. There was a peculiar slowness in motion, and the general activity of the flexor muscles was reduced. The "Berührungsreflexe" of Munk and the placing and hopping reaction of Rademaker were also defective. The defects, on the whole, were less severe than those following removal of the motor cortex. Histological studies showed degeneration of the pyramidal tracts and a varying amount of injury to the medial lemniscus and interolivary fibers.

PYRAMIDAL LESIONS IN THE MONKEY

Lesions have been made in the pyramidal tracts in monkeys by Rothmann, Schüller, and Schäfer. Rothmann ('01–'07) cut the decussation by the dorsal approach of Magendie, finding the ventral operation too difficult in these animals. He observed an initial defect, but a return of even the finest finger adjustments after eight to fourteen days. He made many combined operations, cutting the decussation along with other parts of the central nervous system and came to the final conclusion that the pyramidal tracts in the monkey possess no specific functions which cannot be taken over in large measure by the extrapyramidal pathways. Only in the speed of its movement is the monkey without pyramidal tracts behind its normal fellow, "a fact which, in view of the marked reduction in the total area of the motor pathways from the cerebral cortex to the spinal cord is not surprising." Rothmann ('04) attempted to cut the pyramids in chimpanzees but without success.

Schüller ('06) succeeded in making unilateral lesions in one pyramid from the ventral approach in two monkeys, one complete, the other incomplete. The defects were more severe here than in his dogs and more so than in Rothmann's monkeys. After two weeks prehension of food was carried out poorly by the affected hand, the legs were used stiffly and awkwardly in movement, and there was the same difficulty in sideward motion ("Flankengang") seen in the dogs. This test by Schüller appears to be the forerunner of Rademaker's hopping reaction (Hinkebein).

Schäfer in 1900, in a footnote in his *Textbook of Physiology* states briefly that he was unable to confirm Starlinger's findings in the monkey. In 1910, he described in detail the effect of injury to the pyramids in three of these animals. In two, the damage was chiefly unilateral, and in one, both pyramids were almost completely severed. He was particularly interested in "voluntary" movement and for this he employed three tests. First, the ability to pick up currants from the floor and to carry them to the mouth; second, the tendency of the limbs to reach for contact on swinging or dropping the animal towards a cage or to the floor; and third, the use of the hands in grasping. He considered the second the best test for voluntary movement in the hind limb, the third as variable and rather dependent upon the disposition of the animal. Schäfer states, "It is noteworthy that after 21 days there is manifested a considerable amount of voluntary movement of the paralyzed arm, but none up to 28 days of the corresponding leg, unless its increased facility in walking, climbing and leaping is to be taken as evidence of such recovery."

THE PATHWAYS MEDIATING THE RESPONSE ON ELECTRICAL STIMULATION OF THE MOTOR CORTEX

The experiments reported above relate entirely to the functional defects produced by lesions of the pyramidal system in the medulla. This does not, however, cover all the functions assigned to the pyramidal tracts for they have long been regarded as mediating the response on electrical stimulation of the motor cortex. Indeed they are often regarded as being the only tract capable of underlying this reaction, although the bulk of experimental evidence is against this conclusion as will be seen from the sections to follow. These experiments are mostly of an acute nature and were performed on rabbits, cats, dogs, and monkeys. As in the previous sections, the findings in the different animals will be reported separately.

EXPERIMENTS ON RABBITS

The central nervous system pathways mediating the response on electrical stimulation of the motor cortex of the rabbit became a subject of experimental investigation shortly after the publication of Fritsch and Hitzig's monograph in 1870. Gliky ('76), working in the laboratory of Eckhard in Giessen, made sagittal sections in the midline of the cerebrum, which extended as far backwards as the posterior colliculi. He found the usual contralateral responses to persist after this lesion and concluded that the decussation of the pathways underlying the reaction must lie caudal to the posterior limit of his sections.

Balighian ('79), also working with Eckhard, traced the pathways further. He made hemisections at various levels of the medulla oblongata from the calamus scriptorius to the tuberculum acousticum. In some, he added to a transverse lesion in the tuberculum acousticum a sagittal midline section which passed from this level caudally to the calamus (fig. 1). When these lesions were made on the right, thus sectioning the right pyramidal tract—meaning the pyramidal tract arising in the right cerebral cortex—he found that stimulation of the right motor cortex gave a large response on the left side, while stimulation of the left cortex gave only a feeble movement on the right. He concluded that the crossing of the fibers mediating the reaction must be spread out over a long distance, which extended from above the tuberculum, acousticum to below the calamus scriptorius. Most of the crossing must take place above the medulla and probably, he says, in the pons. Its lower border he did not determine but concluded that there was no evidence that it was "lower than the atlas." A reference to the figure will show that the results could be explained on the basis of the preservation of either the pyramidal or the cortico-rubro-spinal system. The findings would further suggest that the cortico-rubro-spinal tract must be the more important since a greater response was obtained on the side on which it was intact.

By far the most prolific writer of this early period was Brown-Séquard (1879–1889) who vigorously opposed the two theories then current as to the pathways involved. These were first the doctrine of Ferrier, that the essential pathway was the pyramidal tract with its decussation in the medulla, and second that of Schiff, and Lussana and Lemoigne, who argued that it was not the pyramidal tract but another with its decussation in the pons. Brown-Séquard made hemisections of the medulla, pons and cerebral peduncles and claimed that not only were contralateral movements still possible from stimulation of the motor area on the side of the lesion, but that the responses were even greater than before. The response was unaffected by section of the corpus callosum. On the other hand, the middle third of this structure was electrically excitable and from this and other evidence he concluded that the corpus callosum carried an alternative pathway for movement. He made midline sagittal sections of the pons and even "from the superior part of the cerebral peduncles to below the pyramidal decussation" (Fig. 2a) and found—provided the animals survived—movements still possible from cortical stimulation, although much reduced.

In addition to these single lesions Brown-Séquard combined two or more sections and claimed some astounding results. Thus a combined midline section of the pons with a hemisection of the right half of the medulla (Fig. 2b) did not abolish the excitability of the right motor cortex. A combined section of the corpus callosum with a hemisection of the right half of the pons (Fig. 2c) did not abolish the excitability of either cortex, although the response in the contralateral limb was smaller on stimulation of the right hemisphere as compared with that of the left. Even two hemisections of the brain stem on different sides, one high up in the pons on the right, the other in the middle of the medulla on the left (Fig. 2d) not only failed to suppress the cortical response but in some cases actually augmented it. A reference to figure 2 will show that of the four cases shown, two, (b) and (c), could be accounted for by the preservation of either the pyramidal or cortico-rubro-spinal systems. In (a) and (d) all of these tracts are cut, and the response must be mediated by other pathways.

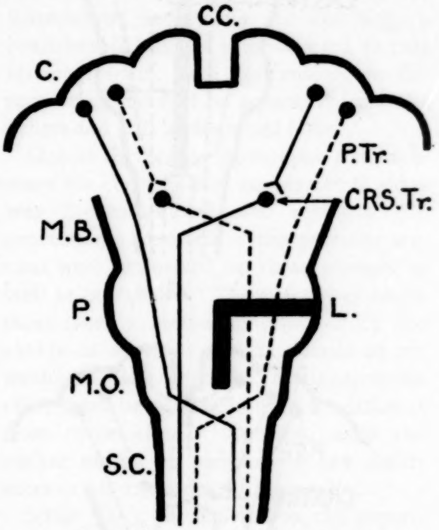

FIG. 1. BALIGHIAN'S EXPERIMENTS

C—cerebral cortex. *CC*—Corpus Callosum. *CRS. Tr.*—Cortico-rubro-spinal tract. *L*—lesion. *M.B.*—midbrain. *M.O.*—Medulla oblongata. *P*—Pons. *P.Tr.*—Pyramidal Tract. *S.C.*—Spinal Cord. Tracts in uninterrupted line are functional; those in interrupted lines have been sectioned and are non-functional.

In 1889 Brown-Séquard published his classical paper on section of the pyramids in the medulla and of all of the medulla except the pyramids. He used rabbits and dogs, and found that after sections of the pyramids alone the response from cortical stimulation was as great or almost as great as before. After section of all but the pyramids a response was still present but considerably reduced. He concluded on the basis of this and all his previous work that the pyramidal tracts were certainly not the only pathways mediating these reactions, that they were not even the chief ones; and that the connections between the brain and spinal cord were more numerous than had been commonly supposed. He violently flayed the phys-

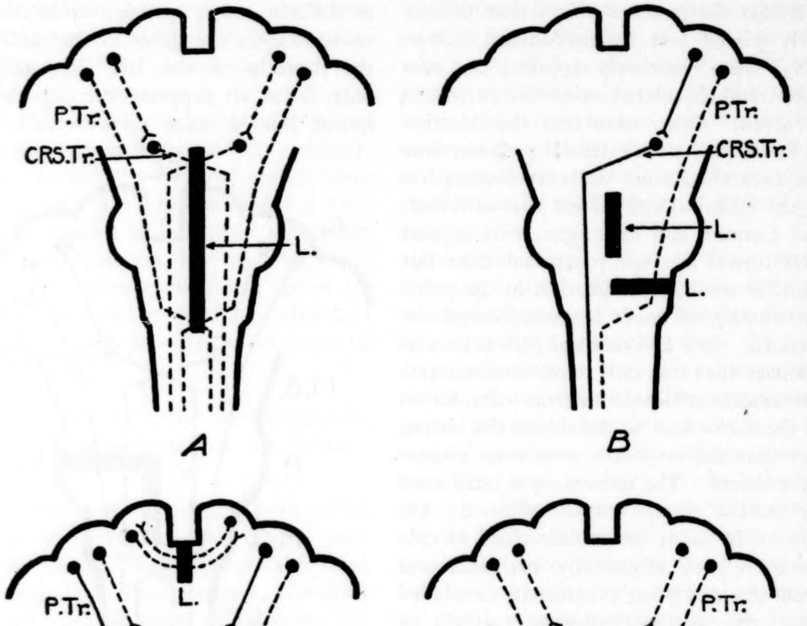

FIG. 2. BROWN-SÉQUARD'S EXPERIMENTS
Explanation in text. Lettering as for Fig. 1

iologists and clinicians of his time who continued to uphold the doctrine of any single localized pathway for these reactions. In criticism it should be noted that he gives only meager accounts of his methodology. He appears not to have differentiated between discrete isolated movements and convulsive reactions, and he provides no objective evidence to show the extent of his lesions. Indeed, one does not know how this latter point was determined.

The observations so far reported refer to the movement in the contralateral limbs from stimulation of one motor area. But homolateral responses had also been observed which were thought by some to be due to the excitations of the opposite cerebral hemisphere by way of the corpus callosum. Exner ('81), however, demonstrated in rabbits, that the homolateral response was not altered by section of the corpus callosum, or even by complete removal of the opposite cerebral hemisphere. He concluded, therefore, that the innervation of the homolateral limb came directly from the cortex stimulated.

Steffahny ('88) continued the investigations started by Balighian. He determined the lower limit of the decussation of the fibers underlying the responses in the contralateral limbs and their position in the upper cervical cord. The lower limit was found to only a minimal amount (a few millimeters) below the tip of the calamus scriptorius and the pathway in its course below this decussation shifted its position. Just below the calamus it appeared to be almost entirely within the anterior column, while at the level of the 4th cervical segment it was confined to the lateral column. This description fits fairly closely the pyramidal tract although the author makes no reference to it. The pathway for homolateral movement passed along with that for the contralateral at the levels studied. The careful description of method by this author forms a striking contrast to that of Brown-Séquard.

EXPERIMENTS ON DOGS

The experiments on rabbits were largely confined to the determination of the pathways for movement on the contralateral side of the body, although a few were aimed at the determination of these for homolateral movement. In the dog, a considerable number were devoted to this latter problem. For convenience in description they will be separated from the others and will be described later.

One of the first to investigate the pathways for contralateral movement in dogs was Brown-Séquard, and some of the experiments reported in the previous section were performed on these animals as well as on rabbits. The exact ones are in most cases a matter of doubt since the author is so scant on the details of his methods. The essential findings, however, must be assumed to be no different from those already reported, since the author makes no mention of any differences in his discussion of his results.

Schiff ('83), in addition to the experiments with chronic animals already reported, made a number of acute experiments on dogs. He reports an animal in which prior to a section of the lateral column of the cord the discharge of four Leclauché elements applied to the motor cortex produced a large movement in the contralateral side, while after the lesion a current of this strength had no effect. With increasing strengths, homolateral movements first appeared until finally when fourteen elements were used "a general reaction of pain" appeared in which the contralateral limbs weakly participated. These experiments of Schiff are the first to give evidence that interruption of the tracts of the lateral column including both the pyramidal and rubro-spinal systems will render the contralateral cortex inexcitable for discrete movements.

Dupuy ('86) reported sectioning one "peduncle" in three dogs. Stimulation of the cortex on the side of the lesion with a coil at 12 cm. produced light movements on the contralateral side and when the coil was increased to 5 cm. a violent epileptiform convulsion occurred which involved the whole animal. The exact amount sectioned is not clear from the report.

Starlinger ('95, '97) stimulated on the seventeenth day the motor area of one of his animals in which both pyramids had been removed. He obtained a "prompt response" in the contralateral extremities and concluded, therefore, that this reaction was not mediated solely through the pyramidal tracts.

Stoddart ('97) sectioned the pyramidal decussation in twelve dogs and obtained movements in the contralateral hind legs, but none in the forelegs or trunk. He considered the positive responses to be mediated by the direct pyramidal tract.

Prus ('98) was solely interested in the pathways underlying the epileptiform convulsion following strong stimulation of the cortex. He cut one pyramidal tract along with other structures in the internal capsule, peduncle, pons, medulla and the lateral column of the cord and concluded that its interruption in any of these regions did not prevent the appearance of the seizures. Bilateral sections of the tract in the peduncle, pons and medulla were likewise without effect. On the other hand, lesions made in the tegmentum of the midbrain at the level of the inferior colliculi which did not pass deep enough to effect the pyramidal tract abolished the convulsive response, although "isolated movements" remained. This curious finding has never been confirmed.

By far the most extensive and at the same time completely controlled experiments of this period were done by Hering ('99). He used twenty dogs in acute experiments of many varieties, and found that after section of the pyramids isolated movements could be obtained in the contralateral legs which were somewhat easier to elicit in the hind limbs (13 cm. coil) than in the fore (10 cm. coil). It was also possible to inhibit a contralateral extensor tonus with a weak current. With a current of greater strength cortical epilepsy could be obtained. Hemisections of the medulla made at various levels did not abolish the contralateral movement. He concluded that in addition to the pyramidal tract there must be a "second cortico-fugal path" and that this path must decussate above the medulla. By combining medulla and cord hemisections on different sides he tried to isolate each of these tracts separately. Thus a right medulla hemisection combined with a left cord hemisection (Fig. 3a) isolates the pyramidal tract arising from the left cerebral cortex while a medulla and cord hemisection on the right (Fig. 3b) leaves intact the "second cortico-fugal path" from the right cortex. By these and other methods he determined that not only the pyramidal tract but the "second cortico-fugal path" was capable of mediating both isolated movements and convulsions. The "second path" was found to run with the pyramidal tract in the lateral column. Reference to the figures will show it can be identified with the rubro-spinal tract, as was pointed out by Rothmann.

Rothmann ('01, '02) observed the effect of cortical stimulation on the contralateral limbs after lesions of the pyramidal and rubro-spinal tracts in seventeen dogs.

The pyramidal tracts were cut at their decussation and the rubro-spinal systems were sectioned in the medulla. He found that pyramidal lesions only slightly reduced the excitability of the cortex on the side of the lesion so that, for example, when the coil on the normal side ranged from 10 to 11 cm. that on the damaged side would be around 8 or 9 cm. Lesions of the rubro-spinal tract alone did not affect the response, but combined lesions of the pyramidal and rubro-spinal systems completely removed the reaction.

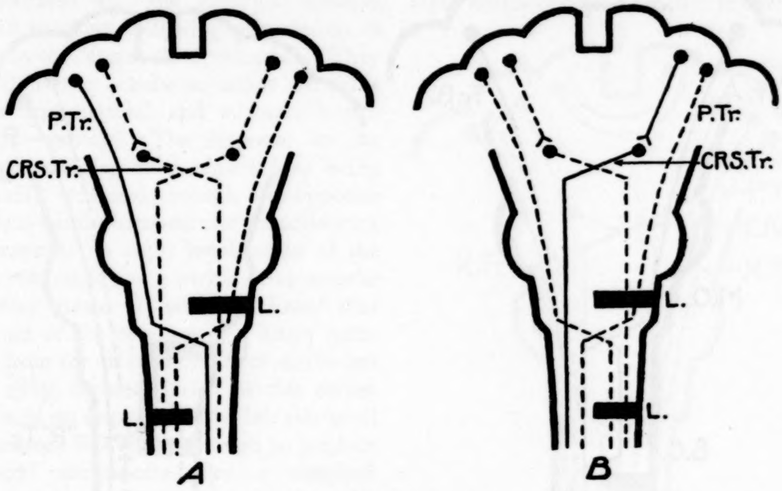

Fig. 3. Hering's Experiments
Lettering as for Fig. 1

The homolateral responses in the dog have been studied by Francois Frank and Pitres ('78–'79), Lewaschew ('85) and Wertheimer and Lepage ('96–'97). Francois Frank and Pitres ('78) made kymograph recordings of the movements of both hind legs from stimulation of one motor area and showed that the homolateral response was less energetic and definitely delayed as compared with the contralateral. They did no experimental work to prove their thesis but contended from general reasoning that the pathway to the homolateral limb first crossed to the contralateral side with the main descending fibers and then "re-crossed" to the homolateral limb.

Lewaschew in 1885 set this hypothesis to test. He stimulated one motor area and obtained a bilateral response of somewhat different character on the two sides. He then made a left hemisection of the cord at the 12th thoracic level and found that on stimulation of the left motor area the homolateral (and contralateral) response was unchanged. He concluded that the pathway to the homolateral hind leg crossed in the pyramidal decussation and then "re-crossed" in the lumbar region (Fig. 4, Tr. A). Stimulation of the right cortex produced no response in the left hindleg but a movement on the right, so there must be, he argued, an alternative recrossing above the 12th thoracic (Fig. 4, Tr. B). He concluded that the hypothesis of Frank and Pitres was correct.

Wertheimer and Lepage ('96–'97) contested these conclusions on the basis of some very ingenious experiments. They made a left hemisection in the medulla above the pyramidal decussation and found that stimulation of the right cortex gave a normal response in the left legs. They then made a left hemisection in the upper cervical region of the cord and found that the left leg movement had dropped out and that a right leg (homolateral) movement was now present. They next made a midline sagittal section connecting the two hemisections and sometimes actually removed the intervening block of tissue on the left (Fig. 5). If the recrossing theory was correct, this procedure should obliterate the homolateral movement since the region where the recrossing must take place, i.e., between the pyramidal decussation and the cervical hemisection, (Fig. 5, "R" Tr.) was removed. What actually happened was that the homolateral movement continued as before. To check the unlikely possibility of a recrossing more cranially they carried the sagittal section forwards through the pons but found that this made no difference to the result. They, therefore, decided against Lewaschew in favor of a direct homolateral tract (Fig. 5, "D" Tr.). They further observed that stimulation of the left motor cortex following a left medulla hemisection above the pyramidal decussation still produced a contralateral response, thus confirming several earlier observers in this respect.

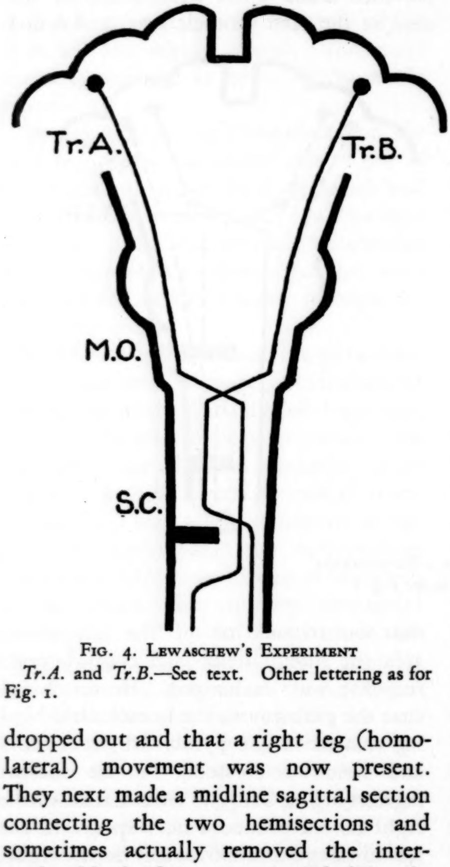

Fig. 4. Lewaschew's Experiment

Tr.A. and *Tr.B.*—See text. Other lettering as for Fig. 1.

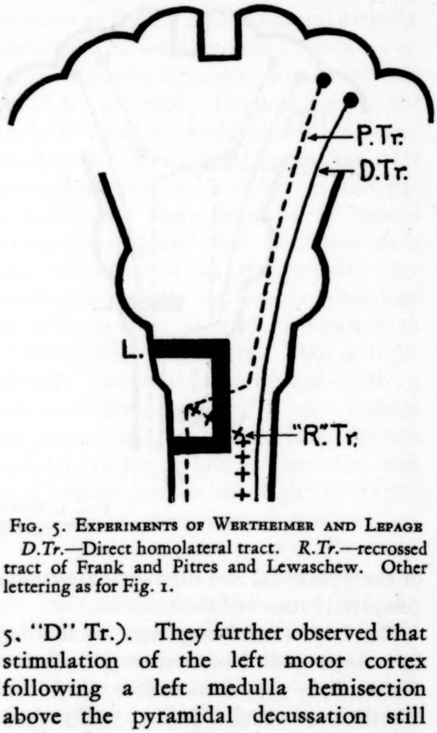

Fig. 5. Experiments of Wertheimer and Lepage

D.Tr.—Direct homolateral tract. *R.Tr.*—recrossed tract of Frank and Pitres and Lewaschew. Other lettering as for Fig. 1.

EXPERIMENTS ON CATS

The number of investigations on the pathways underlying the response to electrical stimulation of the cortex in the cat is relatively few. They are reported by Brown-Séquard, Gotch and Horsley, Probst, and Economo and Karplus. The observations of Brown-Séquard have already been discussed.

Gotch and Horsley ('91) investigated the pathways for homolateral movement by a unique method. They transected the spinal cord and then split the caudal end of the oral portion in the midline. Galvanometers were attached to each half so isolated and the electrical changes found in them following stimulation of the motor areas were recorded. They found in the otherwise intact animal a large contralateral and a small homolateral response. The response in the homolateral leg they regarded as being probably mediated through the opposite cerebral hemisphere and cite the following experiment. A right hemisection of the cord was made and a period of 2½ months recovery given. It was then found that in spite of the presence of a direct pathway from the left motor cortex to the left cord (Fig. 6) stimulation of this cortex produced no response on the left side until the current was strong enough to produce bilateral movements. For a complete understanding of this phenomenon the effect of stimulation of the right cortex on the right cord below the hemisection should be known, and it is unfortunately not clear from their report whether this was zero or was merely not observed. The proof of their thesis would require a positive response in this situation, as can easily be shown. Thus in their first experiment (without cord hemisection) the pathway mediating the response on the left side from stimulation of the left motor cortex is assumed to pass first to the right hemisphere and then downwards, "recrossing" somewhere in its course to the left side. In their second experiment (with a right cord hemisection), since there is now no response on the left side from the same stimulation, the descending path from the right cortex cannot be the crossed pyramidal tract or the cortico-rubro-spinal system for these are uncut. The tract must, therefore, be one that crosses in this cord below the hemisection (Fig. 6, X. Tr.). But such a path descending on the left side is uncut and should be capable of producing a response on the right side from stimulation of the right motor cortex. Finally, in their one animal in which they removed the cerebral hemisphere opposite to the one stimulated, the homolateral response remained just as large as before.

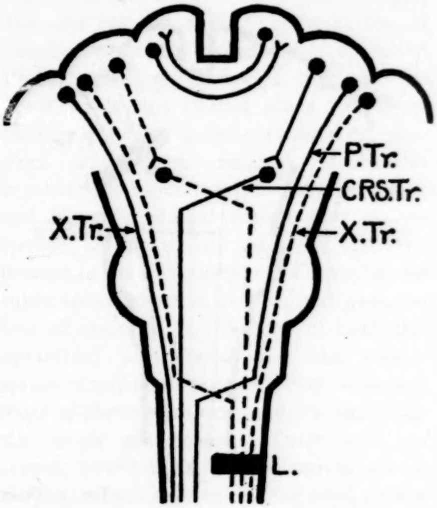

Fig. 6. Experiments of Gotch and Horsley
X.Tr.—See text. Other lettering as for Fig. 1

Probst ('01, '05) made an enormous number of experimental lesions at various levels of the central nervous system, many by means of a special instrument devised by him, the "Hakenkanule." His findings refer to the contralateral response only and are briefly as follows. Complete lesions of the internal capsule abolished all responses from the motor cortex of the same side. Lesions confined to the pyramidal portion of the capsule did not obliterate the reaction but reduced the excitability so that individual movements required a stronger current, epileptiform convulsions an enormous one. Lesions of the thalamus itself also caused a reduced excitability. A complete hemisection of the midbrain cranial to the red nucleus caused a total abolition of the response (Fig. 7a). If only the crus was cut involving the pyramidal and corticopontine tracts, but leaving intact "a path to the red nucleus" the reaction was still present although a stronger current was required. A hemisection between the superior and inferior colliculi (Fig. 7b) which left intact the cortico-rubro-spinal system, produced a similar result. Section of both pyramids in the interolivary region of the medulla reduced the excitability but both individual movements and epileptiform convulsions could be obtained. After a section of all descending tracts except the pyramidal, movements were also possible as stated earlier by Brown-Séquard. Probst finally concluded that both the pyramidal and rubro-spinal tracts were important pathways underlying the contralateral response from stimulation of the motor cortex.

Economo and Karplus ('08–'10) made unilateral and bilateral lesions in the pes pedunculi involving the pyramidal and cortico-pontine tracts. They state that stimulation of the motor cortex on the side of the lesion produced contralateral movements without the necessity of using more than the normal current. There was no difference in the reactions of the fore and hind limbs, or of the larger and smaller joints.

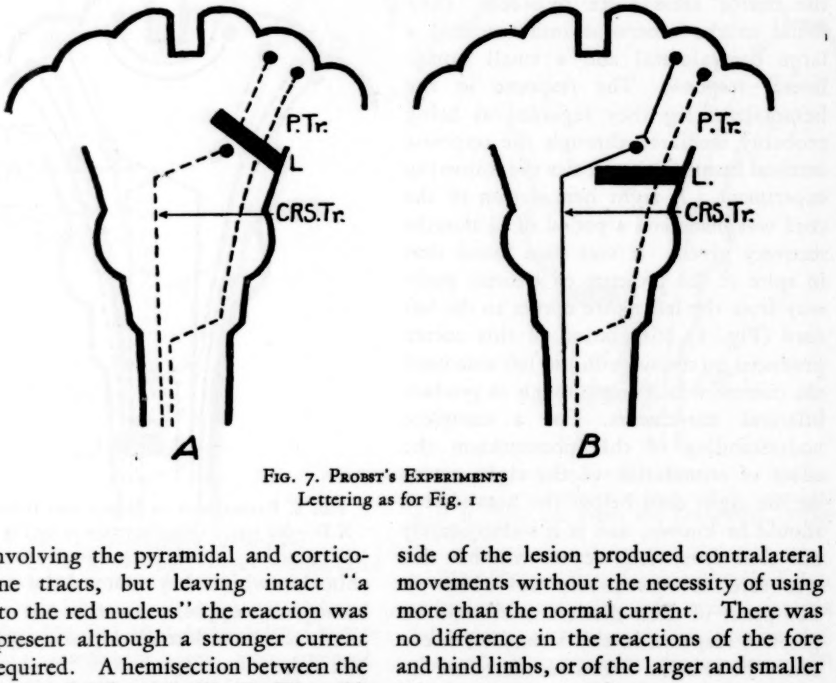

Fig. 7. Probst's Experiments
Lettering as for Fig. 1

EXPERIMENTS ON MONKEYS

Brown-Séquard states that some of his experiments already mentioned were done on monkeys with presumably similar results to those already reported. In a special article ('87) he described a region on the callosal gyrus, stimulation of which produced homolateral movements while stimulation of the motor part of the marginal gyrus just above it produced the usual contralateral response. The further course of the homolateral pathways was not determined. Gotch and Horsley's ('91) experiments included monkeys as well as cats, and the results obtained were the same.

Hering ('99) was the first to make carefully controlled pyramidal tract lesions in monkeys. He used eleven macaques and nine baboons in acute experiments. He found, after cutting the pyramids in the medulla after the method of Starlinger, that isolated contralateral movements from stimulation of the motor cortex could no longer be obtained, a result which differs from his findings in dogs. Homolateral movements could be obtained, however, particularly from an area within Brodmann's area 6, which he designated as sulcus X. Occasionally and with a stronger current associated movements of the contralateral hind leg were added to movements of the homolateral limb. An unexpected finding was that in an animal with only one pyramid cut, the homolateral response was easier to elicit on the side of the damaged pyramid than on the intact side.

Probst ('05) reports a case of section of the pyramidal tract in the pons in one monkey in which at the end of three weeks stimulation of the motor area gave isolated movements in the contralateral fingers. In the larger joints no movements could be obtained. He states that pyramidal lesions in the dog and cat only decrease the excitability of the cortex for contralateral movement while in the monkey there is an actual dropping out of whole movements in the larger joints. After hemisection of the midbrain between the superior and inferior colliculi (Fig. 7b) it was impossible to obtain epileptic convulsions in the contralateral extremities. The presence of the cortico-rubro-spinal system is not adequate for this response in the monkey. Probst confirmed the findings of Hering regarding homolateral movements.

Rothmann ('02) split the pyramidal decussation by the dorsal operation of Magendie in a number of monkeys. He found, after a survival period of two to three weeks, two small areas of excitability in the cortex, one for the fingers and one for the toes. The retention of finger movements is in harmony with Probst's findings, although here the experiment is not crucial since the fibers that do not cross in the pyramidal decussation may have escaped. Rothmann regards the difference between his cases and Hering's animal which gave no response, as due to the period of recovery present in his own cases. A section of the rubro-spinal tract in one animal gave no loss of excitability. Section of both the pyramidal decussation and the rubrospinal tract, also in one animal, removed most of the cortical excitability including the finger movements. There was retained, however, a rotation movement of the arm which may be due, he says, to the fact that some of the pyramidal fibers escaped.

Economo and Karplus ('08–'10) made lesions in the pes pedunculi in five monkeys. In one of these animals with a complete bilateral section of this structure, stimulation of one motor area produced movements in the contralateral extremities. In the upper extremity the movement occurred in the elbow and in the lower extremity in the foot and toes. The strength of current required is not stated. In the remaining four animals the findings are not conclusive since the lesions were either too large or too small.

SUMMARY AND CONCLUSIONS

1. In spite of the fact that the term "pyramidal tract" is a very common one, a certain confusion seems to exist as to just what is included in it. A review of the literature shows that it was *defined* by the older experimental anatomists as the sum of those fibers passing through the pyramids of the medulla into the spinal cord, or as equivalent to the total cerebrospinal system. Definitions which would exclude any cortico-spinal fibers, such as for example fronto-spinal, have no historic sanction. The *conclusion* that the pyramidal tract arises solely from the cytoarchitecturally defined motor area or area 4 of Brodmann, is not well established and there is much evidence against it.

2. Complete interruption of the pyramidal tracts without damage to other efferent systems can only be made by section of the pyramids of the medulla, and the experiment to be crucial should be bilateral. This, with survival long enough for observations on recovery, and with adequate anatomical controls, has been reported by only three observers; by Starlinger ('95, '97) in the dog, Schäfer ('10) in the monkey, and Marshall ('33, '34) in the cat. Section of one pyramid alone and of the pyramidal decussation has been reported by a relatively small number of others.

3. The defects in the dog and cat in those cases in which the lesions were more or less confined to the pyramidal tracts were not great and were on the whole less than those found after removal of the motor cortex. This can be most readily seen in the case of the "Berührungsreflexe" of Munk and the contact placing reactions of Rademaker. These reactions are totally and permanently abolished after removal of the motor cortex but are capable of partial recovery following interruption of the pyramidal system. The "extrapyramidal" outflow from the motor cortex is thus shown to be functionally significant.

4. Extensor hypertonus was not found by the earlier experimenters, e.g., Starlinger ('95, '97) and Rothmann ('00–'07) who worked chiefly with dogs. It has been reported by some recent experimenters, e.g., Ranson ('32) and Marshall ('33, '34) in cats. Where it was found it was not great enough to interfere seriously with movement and often needed special postures to bring it out.

5. In monkeys the number of experiments is few and the severity of the defects varied. The attempt of Rothmann ('04) to cut the pyramidal decussation in chimpanzees was without success.

6. The pyramidal tracts have long been regarded as mediating the discrete responses in the limbs from electrical stimulation of the cortex and are now often thought to be the only tracts capable of underlying these reactions The experimental literature in rabbits, dogs, cats and monkeys is summarized.

7. In rabbits most of the experiments are old and none are found since the turn of the century. Taken at their face value they indicate that the response can appear without the pyramidal tracts, and that of all the fibers mediating the reaction the pyramidal is not even the most important. The interesting if perhaps untrustworthy experiments of Brown-Séquard are summarized and his violent flaying of the physiologists and clinicians of the time who upheld a single localized pathway for the reactions is noted.

8. In the dog and cat a large number of experiments have been made to determine the pathways underlying both the contralateral and homolateral responses from stimulation of one motor cortex. Schiff

('83) was the first to demonstrate that the contralateral discrete response was abolished by section of the lateral column of the cord. Starlinger ('95, '97) clearly showed that section of the pyramidal tract alone was not sufficient to obliterate it. Hering ('99) showed the participation of a "second cortico-fugal tract" which decussated above the medulla. Rothmann ('01, '02) and Probst ('01, '05) showed that this second tract was the rubro-spinal. Probst, and Economo and Karplus ('08–'10) showed that the reaction was present after section of the pes pedunculi. The pyramidal tract appears to play a greater rôle in the reaction in the dog and cat than it does in the rabbit and it is also more important than the rubro-spinal system, although the latter is by no means insignificant.

9. An observation of Rothmann in connection with these experiments is of some general importance. Thus he states that section of the pyramidal tracts alone slightly reduces the reaction; section of the rubro-spinal tract has no effect on it whatever; but section of the two together abolishes it completely. In other words, the rubro-spinal tract plays an important rôle, although section of it alone did not show it. Put in general terms, it means that the failure of appearance of any signs of deficit from section of a nerve tract is not proof that the tract does not play a part in the function tested.

10. The investigations on the pathways for homolateral movements in the cat and dog gave conflicting results. The experiments of Wertheimer and Lepage ('96, '97) may be cited as a very ingenious attack on the problem.

11. The experiments in monkeys are relatively few. Hering's ('99) experiments in a large number of animals show that the response is abolished *immediately* after section of the pyramidal tracts alone. The rubro-spinal tracts are apparently not adequate to mediate the response in those acute experiments. Those who have kept their animals over a survival period of two weeks or more report the presence of some movement. Rothmann ('02) and Probst ('05) in a small number of such animals report the retention of small areas of excitability for the fingers and toes only and Economo and Karplus ('08–'10) report some movements in the larger joints (elbows) in one case.

12. The homolateral response in monkeys is reported by Hering ('99) and Probst ('05) to be easier to elicit from stimulation of the cortex on the side of the damaged pyramid than from that of the sound one. Stated another way, homolateral movements appear more easily when contralateral movements are prevented from occurring. The same phenomenon appears to be present in some of the experiments of Wertheimer and Lepage ('97).

13. Finally, it must be observed that for those who regard the cytoarchitecturally defined motor cortex (area 4 of Brodmann) as the sole site of origin of the pyramidal tracts, any evidence that electrical stimulation of other cortical areas will produce limb movements becomes proof of the "extrapyramidal" mediation of the response. The studies of C. and O. Vogt ('19), Foerster ('31), Bucy ('33), etc., show that the premotor and post-central regions do possess an excitability of a sort, although it differs considerably from that of the motor area. For those who accept the origin of the pyramidal tract given above, e.g., Foerster ('31), this demonstrates that extrapyramidal fibers from these areas can carry out the reaction.

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ADDENDUM

Since the submission of this paper to press, a number of contributions to the subject have been made by various authors. Kennard ('35) and E. C. Hoff ('35) have advanced further evidence confirming the idea already expressed that the pyramidal tract arises from a more extensive cortical area than the primary motor cortex or area 4 of Brodmann. Kennard demonstrated by the Marchi technique, that removal of the premotor area (area 6 of Brodmann) of the monkey causes a definite cortico-spinal degeneration. Some of the degenerating fibers descend directly from area 6; others first pass backward through the cortex to area 4 and then descend. E. C. Hoff by the method of *bouton* degeneration came to the same conclusions. On the other hand, Levine and Poliak, in a paper read before the American Neurological Association, could find little evidence of any significant cortico-spinal degeneration from lesions of the premotor area.

The functions of the pyramidal tract have been studied by section of the pyramid in the medulla by Barron in the rat, by Tower in the cat, and by Tower and Hines in the monkey.

In the rat Barron ('34) found disorders

in posture, in gait and in the grasp in the contralateral limbs—the forelimbs suffering more than the hind. There was a paresis in the toes and a decrease in "flexor tone." The affected foreleg was extended with difficulty at the elbow joint, and it was often misplaced, so that it crossed the opposite foreleg, or was placed on the dorsum of the foot. The gait improved rapidly, but the power of grasp returned slowly and never fully reached the normal. The placing and "postural adjustment reactions" of Rademaker were initially absent, and showed no recovery during the survival period of the animal (a maximum of sixty days). Electrical stimulation of the cortex after the lesion gave no response when tested with the bipolar method. With unipolar stimulation, no flexor responses could be elicited, but extensor movements could be obtained. On the intact side, the preponderance of responses was flexor. The conclusion was drawn that the pyramidal tract "is chiefly concerned with the regulation of flexor movements of the fore limbs, especially of the digits and manus."

In the cat Tower ('35) found disorders in gait, in posture, and in the placing and hopping reactions. The observations on tone deserve special consideration for the conclusion is reached, in contrast to those of Ranson and Marshall, that "the basic postural mechanism of extension is intact, symmetrical and not overactive." Certain signs which superficially might give the appearance of extensor hypertonus were admittedly present. Thus, in the gait the extremities were used "stiffly with little or none of the characteristic triple flexion," there developed a "circumduction . . . resembling that of a hemiplegic man," and "in running and jumping the stiffness was frequently so great as to throw the animal towards the normal side." Extensor postures were not infrequently maintained when the normal extremities had flexed. The knee jerk "was larger and longer enduring than on the normal side, and occasionally this leg retained a residue of the extension. Yet if the animal relaxed during examination the difference between the sides diminished, until on the verge of sleep the jerks became symmetrical, and both of the loose type previously characteristic of the side opposite the lesion." In the supine position, little or no resistance was encountered on passive flexion.

The interpretation placed by Tower on the phenomena of extension noted above, is that they are dependent upon a "deficiency of flexor activity." Thus the extensor postures appear "as a normal extension abnormally prolonged because of a deficiency in flexor activity." The apparent overactivity of the extensors in the knee jerk is "due to the operation of active flexion in checking the normal jerk and the lack of such flexion on the incompletely innervated side." The conclusion is drawn that "the lack of clonus in the post-operative syndrome and of a clasp knife phenomenon, indeed the conspicuous absence of all signs of spasticity, together with the very moderate resistance to passive movement, sufficiently demonstrated that severing the pyramid had not increased the excitability of the spinal extensor centers as does the hemiplegic lesion in man."

The findings on cortical stimulation were interesting, and it is stated that posture placed a most decisive rôle in the results. In the supine position, stimulation of the intact side, produced first a relaxation of a pre-existing extensor tonus (presumably the result of the anesthetic) and secondly, with a little stronger current, an active flexion. On the affected side, relaxation (inhibition) of the extensor tonus could be produced, but active flexion was never obtained. In the prone position in one animal "the lateral border of the anterior sigmoid gyrus gave a curious slow retraction and flexion of the opposite forelimb, and that was all." It is not clear from the report what were the findings in the prone position in the other animals, and if both the prone and supine positions were used in the same animals.

As a final conclusion it is stated that the experiment shows that the excitability and inhibitory components of cortical activity are dissociated at some pre-spinal level; that the excitatory component travels along the cortico-spinal tract; and that the inhibitory component descends to the cord along other pathways. In criticism one may question (1) whether the extensor phenomena can be satisfactorily explained away as a deficiency of flexor activity, and (2) whether the thesis of excitation-inhibition dissociation as formulated by the author is proved by the experiment. The data as given are not sufficient to permit an accurate analysis of all the complex factors involved. The findings on inhibition, moreover, are in part confirmed and in part denied by the recent extensive investigations of Rioch and Rosenblueth ('35) on the subject. That there is a difference between the phenomena resulting from motor area removal and pyramidal section is unquestioned,—such differences have been commented upon by every investigator who has compared the two lesions. But whether these differences are dependent upon a fundamental excitation-inhibition dissociation may be very seriously doubted.

Tower and Hines ('35) in a preliminary report state that section of the pyramid in the monkey produces a syndrome similar to, but graver than that found in the cat, again without spasticity. Stimulation of the motor, premotor and prefrontal areas (especially the premotor) following the pyramidal lesion causes a "release" of tonic closure of the fingers into a grasp. The fine type of movement characteristic of the normal motor cortex can no longer be obtained, but the larger so-called adversive movement may be elicited, as can Jacksonian seizures. No comment is made by the authors as to whether the excitation-inhibition dissociation is considered as applying in the monkey.

ADDITIONAL LITERATURE

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THE GENE, ITS FUNCTION AND ITS MEANING IN GENETICS

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THIS study will only be a critical survey of the theory of the gene, that is, the theory of the genetical units. These units, the genes, are, according to some authors, thought to form the atoms of organization. According to this conception the genes would be the activators of all the processes of life, even of the most fundamental ones, which result in the totality that we call an organism.

Goldschmidt (1928, p. 508) says that "die Gene Glieder eines Systems sind, nämlich der Eizelle mit Kern und Plasma am Ausgangspunkt und des gesamten Keims an jedem weiteren Punkt der Entwicklung."

In this study we will discuss the function and structure of the gene in relation to the problem of organization and test the facts on which these hypotheses of the atomistic structure of life are founded.

HISTORICAL SURVEY

We will give here only a short review of the history of the above mentioned conception. The "physiological units" of Spencer form its origin; however, it was Darwin, with his "provisional hypothesis of pangenesis" (1868), who laid the foundation of all later hypotheses. Studies on the genetic behavior of plants and animals but even more the general facts of biology, for instance, regeneration, sex, development, induced him to this.

According to him each living creature is "a little microcosm, a little universe, formed of a host of self-propagating organisms, inconceivably minute and as numerous as the stars in heaven" (p. 404). "Each animal and plant may be compared to a bed of mould full of seeds, most of which soon germinate, some lie for a period dormant, whilst others perish" (p. 404).

The influence of Darwin's hypothesis was enormous and we see that many researchers adopted this way of looking at the structure of the organism. In their excellent study Délage and Goldsmith say: "Toutes les théories modernes- qui lui (hypothesis of Darwin) ont emprunté l'idée de particules représentative, n'ont rien ajouté d'essentiel aux explications proposées par elle." Only de Vries forms an exception. De Vries (1889) localized his units, the "pangenes," in the nucleus of every cell. There they are supposed to be inactive, but at a certain moment leave their place of origin, to go into the protoplasm, to activate this.

All these hypotheses culminate in Weismann's "Determinantenlehre." Weismann invented an elaborate and ingenious system of units of different order. The conceptions of the different authors were united by him into one logical system, which was based on the units of de Vries formed in the nucleus, and Naegeli's division of the organism.

With Naegeli, he divided every organism into two parts, *viz.* two kinds of protoplasm, the idioplasm, which was to serve for propagation and possessed all genetic and organizing properties and the trophoplasm, which was to perish when the organism died. Furthermore he invented units of different order, for instance the "determinants," which determined the different processes. These were units of higher order, formed by the biophores, which were united into ids, and the latter into idants, which were identical with the chromosomes in the nucleus.

If we see in Darwin the founder of the atomistic conception, we must regard Weismann as the man who enlarged it into the system which was to play such an important rôle in experimental biology, that is, not only in genetics, but also in experimental embryology. Two lines of research derive from Weismann. These are of different order; the first is a physiological, the second a morphological one. We will discuss them separately. The physiological one depends on the belief that development and organization are the result of a sum of processes and that every single process is determined by some factor, Weismann's determinant, the gene in genetics. The morphological conception depends on Weismann's systematic orders of units in the chromosome. Authors have tried to catalogue the whole organism in his chromosome-set. They tried to refer every character to the nuclei and believed that then they knew the structure of organization and life. They forgot, however, Goethe's phrase "Fehlt leider nur das geistige Band." But only the latter is responsible for organization and life.

THE MORPHOLOGICAL CONCEPTION OF THE GENE

As we have mentioned already, this conception of the gene is to be traced back in history to Darwin. Schaxel (1922) has pointed out that two principles of genetics are derived from Darwin's work: 1. the historical conception of life with the different consecutive generations. 2. the atomistic view of the organism, which is conceived to be an "Eigenschaftsaggregat." Both principles are in some way or other to be found in modern genetic conceptions, though many researchers do not actually stick to them (Johannsen, Correns, Woltereck and others). Yet there is not such a great difference between the original conception of Darwin and the modern researchers. Darwin thought that in the whole organism there were corpuscles responsible for the forming of the organs, whereas several modern researchers, in imitation of de Vries and Weismann, are of the opinion that only that part which is responsible for development and organization possesses these units. From a unit of organism the gene has become a unit of organization. De Vries' conception "Einzeleigenschaft" has played an important rôle (cf. Johannsen for criticism, p. 406). This point of view is for the greater part based on Mendel's laws, which taught that the different characters were inherited apart from each other. Eventual deviations could easily be explained by cytological researches (e.g. crossing-over phenomena). Starting from linkage and crossing-over, conceptions too well-known to be discussed here, the school of Morgan has made chromosome-maps for *Drosophila*. In these maps they tried to catalogue the whole organism or rather its characters, symbolized by its genes, like the books of a library in the index-system.

However important and interesting these researches may be, they have not led us any further as regards insight into the nature of life and organization. Moreover there are various difficulties on which we will touch but slightly.

Morgan's chromosome-map is based, as mentioned, on the phenomena of linkage and crossing-over. The explanation for this was seen in a breaking of the chromosomes. Winkler pointed out the possibility of another explanation, by his "Konversionstheorie," according to which special factors could be converted. In that case it would not be necessary to assume any breaking of the chromosomes in order to explain these phenomena. Stern opposed Winkler's suggestion to the utmost of his power and produced all sorts of proofs in favor of Morgan's theory. Yet Winkler is not convinced and believes that both explanations hold good.

It is interesting indeed that still other methods have been applied to make a chromosome-map; Muller and Painter (1932) did this when they made a map of the x-chromosome of *Drosophila*. Muller started from the consideration that there was "a lesser frequency of crossing-over, when the genes appeared more crowded" in the chromosome. With the aid of x-rays he could show that there were not only differences in cross-over frequency, but also in mutation-frequency in the different regions of the chromosomes. By means of x-rays he had formerly been able to ascertain in the x-chromosome different spots where it was broken. In order to determine the place in the x-chromosome where the boundary between the two regions lies, that is, between the break-line C and the factor "bar," he assumed that "the physical size of the remainder of the active region to the right of this line is proportional to the frequency of mutation to the right of bar (in comparison with these respective values to left of bar)" (p. 352). The map thus obtained agreed with the real size, found by deletion. By deletion we understand the breaking of a chromosome under the influence of x-rays, after which the remaining parts stick together and an eliminated part sticks to another chromosome. By measuring such deleted chromosomes Muller and Painter could estimate approximately the real distance of factors in the chromosome and thus come to an exact location of these factors.

However, objections can be raised against this "deletion-method." Sturtevant and Schultz (1931) pointed out that it is possible that the x-rays have not only a breaking influence, but also can induce mutation. The occurrence of unknown subgenes in deleted chromosomes points to this.

Muller and Painter found so-called "inert regions" in the x-chromosome in the same manner as was known in the y-chromosome, that is, spots where no factors were present. They think that the x-chromosome originated from a translocation; its right half would be identical with the left half of the y-chromosome, which was connected with the left half of the x-chromosome by a translocation after deletion. The authors account for the inert part by a degeneration process of the genes. On the other hand one might think that in this case the genes have not been formed (cf. below) and that here the more fundamental organizing processes take place.

In this section there should also be a short discussion of some attempts to subdivide the genes. This point of view is similar to that of Weismann with his system of units of different order. Only a short discussion of the "subgene-hypothesis" of the school of Serebrowsky and Thompson's "side-chain theory" will be given. Both served to explain the phenomena of allelomorphism. The Russian researchers started from the so-called "Treppenallele," which were found in the factor "scute" in *Drosophila*. The subgenes which were responsible for these results were "treppenartig" situated in the chromosome (fig. 1). Different objections have been raised to this hypothesis, of which those of Sturtevant and Schultz (1931) seem to us the most important. Agol (1932) had pointed out as a convincing proof that new subgenes appeared with a "deleted" chromosome. We have already mentioned the possibility that we here have to do with an induced mutation. Moreover as Bridges pointed out for the factor "plexus" and Sturtevant and Schultz (1931) for "scute," the properties of the genes depend on the spatial relations which they bear to other genes in the complex ("the dominance of any one gene is a function of the system as a whole"). However, Brink (1932) did not find such an influence in maize. He believes the genes to form groups. With deletion, the chromosomes would in the case of maize break between two groups, in *Drosophila* within one group.

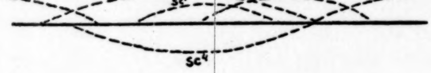

Fig. 1. Series of Step Allelomorphs
Sc³, Sc⁴, Sc¹, Sc², Sp. (Agol, 1931)

These spatial relations of the genes are altered with deletion, which argues against Agol's view. Moreover the threshold value plays a part as Sturtevant and Schultz could prove for "achaete" and "scute." The latter influences the development of the brushes of *Drosophila* only when "hairless" is present (that is, when the threshold-value is reached).

The subgene-hypothesis is no longer in the center of interest. Dubinin (1932) abandoned the hypothesis and now there is only Agol as the courageous, but unconvincing defender.

Thompson has put forward his side-chain theory to account for the phenomena of multiple-allelomorphism; according to him (1925 and 1931) the gene consists of "a main particle firmly anchored in the chromosome with varying numbers of one or more kinds of other particles attached." The first are called "protosomes," the second "episomes." Mutations would mostly arise from loss, sometimes from increase of one of the episomes.

It is difficult to give one's opinion on this hypothesis; this cannot be done until more is known about multiple allelomorphism.

Finally we wish to remind our readers that just as Weismann united his biophores into determinants and ids, other researchers have done this too, e.g., Plate in his Erbstockshypothese (1925) in order to explain the phenomena of development and organization (cf. below). Friesen (1932) tries something similar with his theory of the "Kettenmutationen" (cf. below).

Herewith we finish our exposition of the morphological conception of the gene, to return to it in the discussion of the organization.

THE PHYSIOLOGICAL CONCEPTION

In connection with the well-known researches in physiology and experimental embryology the geneticists have tried to determine the structure and function of the gene. This way of looking upon the matter joined up with the data from experimental embryology, that is, both geneticists and embryologists tried to project back the cause of all kinds of phenomena to a material basis.

As the geneticists thought of this basis as being in the genes localized in the nucleus of the cells, so the embryologists saw it in special parts of the eggs of embryos in the so-called "organ forming substances." These are of such great importance that Penners (1925) has proved that only the cells with pole-plasm (containing the organ forming substances) can form a germ-band, whereas the other parts of the eggs are not able to do so. Schleip (1927) even maintains that in all probability the above-mentioned can be applied in the case of all animals where the spiral cleaving type occurs (Polychaeta, etc). However, the animal pole-plasm behaves differently in those forms which have a trochophora during development from those without a larval stage.

It seems difficult to us to pronounce an opinion on this; however, this is easier for the so-called "organizer" in the development of amphibian eggs and especially of the eggs of the Urodela. If we go more deeply into this subject it is to show how the ideas of organization and induction which originally seemed to give the fundamental solution of development, in the end have not led us any further but that they have been the cause of a great number of fine and important researches.

Spemann was the first to discover that the chorda-mesoderm-plate was able to induce the ectoderm, which in a normal case would have produced skin, to form a neural plate (secondary) with sense organs; the organizer often differentiated itself into chorda and myotomes and then an intestine was formed. So there arose a more or less complete secondary organism (organization). With later researches it has been proved that the neural plate or parts of the central nervous system were able to do the same.

Through this a severe shock was given to the implicit belief in the organizer. Researches by Goertler and others into which we cannot go here, have largely contributed to this, as they taught that the ectoderm was not nullipotent but totipotent. Apparently the induction process does not serve to "induce" something new, but to regulate the processes of development and to conduct them in some special direction or other. Of late years this opinion has taken firmer root through the frequency and multifariousness of the organizing bodies and processes. We shall mention only a few of them; differences in temperature (Gilchrist, 1928), killed parts of embryos, neural plate and chordamesoderm plate (Spemann and pupils), cancer and muscular tissue (Hampe, see Woerdeman, 1933), and the most varying parts of amphibian embryos (Holtfreter, 1933).

Of late a hypothesis of Woerdeman's that glycolysis plays an important rôle in the process of induction has come to the foreground. Fischer and Wehmeier (1933) thought that glycogen is the induction matter; Woerdeman wants the process "glycolysis" to play a part. However, Waddington and J. and D. Needham and also Holtfreter maintain that it would be a substance with lipoid character. However this may be it is of less importance to us. Woerdeman writes: "Der Induktor hätte als Ausgabe durch seinen eigenen Stoffwechsel die physikalischen und chemischen Milieuveränderungen hervorzurufen, wodurch die physicochemischen Differenzierungen des Reaktionssystems in eine gewisse Richtung gelenkt werden."

We have gone into this question rather elaborately, because many geneticists see an agreement between the working of the organizer and the genes. Originally both were looked upon as chemical substances which have an important influence on development.

The opinion that the genes are enzymes can be traced back to Driesch. According to others they are autocatalyzers. An important expansion was only possible when Goldschmidt in imitation of Hagedoorn, developed his nowadays so important physiological theory of heredity according to which the genes are quantities of hormone and enzyme. According to this theory the gene would only be an autocatalytic substance-particle of not only a definite quality, but also of a definite quantity. The gene now is put in action when the suitable substrate is present, and determines the result of a reaction. The development of an organism, according to Goldschmidt, can be resolved into a number of chain-reactions with an organ forming substance for everyone of them, which determines the differentiation. This conception is the result of a great number of genetical and experimental researches which were made by Goldschmidt and his pupils. At the same time we wish to recall to mind the fine researches of Huxley and his cooperators; the researches on *Lymantria* and *Gammarus* form the most important work in this respect. We are of the opinion that a discussion of these well-known researches is redundant. Huxley has further been able to explain phenomena from palaeontology and the relationship of animals on the basis of the work of d'Arcy Thompson. The latter drew complete animals or special organs in a square lattice-work; by deforming this lattice-work in different directions he obtained forms of kindred animals or the shape of the organs in kindred species of animals (cf. figs. 2 and 3, on the pelvis of *Archaeopteryx* and *Apatornis*.) The cause of this, as d'Arcy Thompson (1915) had already remarked, lay in an "increase or decrease in some or more of the actual and relative velocities of growth" (cf. de Beer, 1930). Huxley pointed to the connection with the working of the genes, as these have a similar influence.

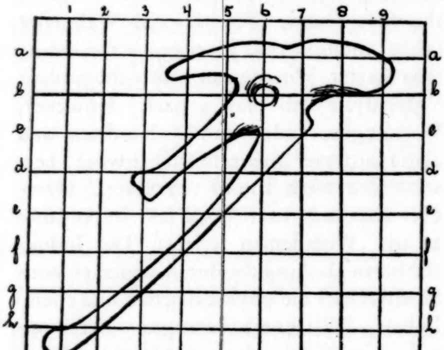

Fig. 2. Pelvis of Archaeopteryx

However, it follows that the genes do not "determine" the development and the differentiation, but only "control," in other words, conduct in a definite direction (cf. below). We become more convinced of this conception through some modern researches.

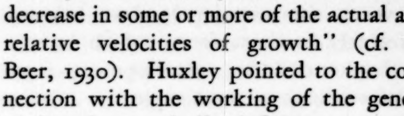

Fig. 3. Pelvis of Apatornis

Lillie and Juhn (1931) studied the physiology of the development of the breast- and saddle-feathers of the brown Leghorn fowl, that is, the influence of thyroxine and the female sex-hormone on the design of the feathers. They found that smaller quantities gave an axial design and larger quantities caused stripes throughout the whole feather or designs along the edge. So these researches argue in favor of the view that the abovementioned hormones play an integrating part in the origin of feather designs. Against this, objections have been raised by Danforth (1933) who thought that the genetic constitution of the animals experimented upon had an important influence on the results. He therefore repeated these experiments with animals with different genetic constitutions and noticed that he had been right. Danforth maintains that "it is primarily the tissues and not the hormone which determine the effect." Montalenti, a pupil of Lillie, found in the Plymouth Rock fowl that the barred pattern results from the cooperation of both genetical and physiological (intermediate hormone-acting) factors (*J. Exp. Zool.*, 69: 269). This is in harmony with the lack of "Nachwirkung" of a hormone, as the investigations of Kemp (1933) on a recessive dwarf stock of the mouse illustrate. This abnormality is the result of an insufficient action of the pituitary, as could be demonstrated by transplantation of this organ of a normal individual into a dwarf which then became normal in size. If the latter was crossed with a genetically normal individual dwarfism reappeared in the children (F_2).

The best way to express the importance of genes is by quoting the words of Huxley and de Beer (1934): "While the genes are by themselves incapable of initiating the processes of development and differentiation, it is obvious that they play an active part in the control of these processes, once development has been started and their presence is essential" (p. 403).

So we see that in experimental embryology as well as in genetics attention is once more drawn to the cause of organization, the nature of which is still unknown to us, in spite of the many attempts made to understand and to explain it. (cf. below).

This section must not be concluded without pointing to the fact that objections have been raised to the conception that the genes are hormones.

Contrary to the conception of quantity of hormone, defended by Goldschmidt, Fisher has remarked that this is incompatible with the results of crosses between the allelomorphs of one gene. The products of such a cross, the so-called "compounds," should always be intermediate and dominance of one allelomorph over another should never show itself, as has been observed. Apparently other factors besides differences of quantity play a part in this case. The problem of multiple allelomorphs has by no means been solved, as Plate remarked. Inexplicable under Goldschmidt's conception is the discovery of Timoféeff-Ressovsky (1932) that in the case of *Drosophila* different allelomorphs already known could be obtained by means of x-raying from the gene white and that these could be converted into each other, e.g., eosin-blood, etc.

The conception that the genes are hormones has also been objected to. Various physiologists doubt the exactness of the hormones and believe that nerves serve for the conduction of the stimuli. It is not possible to express an opinion in this matter; we only point out that Kondratjew (1933) considers the genes to be the total of the electro-magnetic fields and rays, emitted by nucleo-proteids of the nucleus. This conception, however, is not based on researches, but only on deductions and hypotheses, lacking a convincing foundation. We mention it for the sake of completeness only.

Without having striven after any completeness at all, we believe that nevertheless we have put forward and discussed some important points about the physiology of the gene in this section.

THE PROBLEM OF ORGANIZATION

In the introduction it was mentioned that some geneticists regard the organism only as an "Eigenschaftsaggregat." Yet this point of view is not accepted by all researchers. The organism is not the result of a summing-up of characters, in the same way as a more highly organized, "celly" individual is a colony of protists, for in both cases we have to do with a unity, a totality. It is difficult, if not impossible (Lubosch) to give a definition of the idea "organization," but we may describe it as a harmonious coöperation of the different parts of an organism, which on the one hand are to some extent independent of each other, but on the other hand are subject to the influence of the whole.

These phenomena prevented most geneticists from accepting the "Eigenschafts-aggregats" hypothesis as correct; as did also those characters which were the result of different genes and most of all the heredity of the organization characters, which did not follow the laws of Mendel. The difference between the latter and the ordinary mendelizing characters (cf. below Rensch) was difficult to explain with the aid of the atomistic conception. Some authors tried to explain it by means of quantitative differences. According to them the heredity of stature in man and of racing capacity in the thoroughbred horse is not the result of one or of a few genes, but of a thousand. Other researchers did not believe in such a simple explanation and tried to save as much as possible with the aid of different subsidiary hypotheses or to find a new manner of explanation.

The difference between simple and organ forming characters has been the cause of several dualistic hypotheses. All researchers agree in localizing the first in the chromosomes; but they place the latter either in the nucleus or in the protoplasm.

Friesen (1932) proposed the theory of "Kettenmutationen." It was assumed that during a mutation a row of genes mutated simultaneously, but that the only observable effect was caused by both end genes of this row. This hypothesis was proposed to explain the simultaneous occurrence of changes in eye-color and fertility in the different allelomorphs of the gene "white" in *Drosophila*.

This hypothesis has little or nothing to do with the explanation of organization, but it forms the starting point of a possible manner of explanation, that is if we regard such a chain of mutations as a unit of higher order, as Plate (Erbstockhypothese) did. He calls them "Radikale." From the chromosomes they may go into the achromatin of the nucleus, where the so-called "Erbstock" is localized. The last-mentioned is responsible for the organization characters, for as Plate observes we know many genes which influence in some way or other the development of a limb but none which produce its development. The gene "apterous" in *Drosophila* forms a possible exception. In the silkworm a wingless mutant is known which possesses characteristic pupal wing-pockets into which in a normal individual the wing-rudiment projects, which of course does not occur in the wingless form. This makes it probable that we have to do here with a factor which influences the wing development in a negative sense. These organization characters are bound to the ground plan of development. For this reason, other researchers believe them to originate in the protoplasm (Correns, Castle, Philipptchenko and many others). That the latter plays a part in heredity is certain. East (*Am. Nat.* 68: 289) in his critical survey of this subject, is not convinced of this. Jollos (1933) reviewed the different arguments for it. Most important is the often observed fact that the products of a cross differ from those of the reciprocal cross. (Goldschmidt, Kühn for animals; F. Wettstein, Correns, Michaelis and many others for plants).

The experiments on inheritance in the gastropod *Limnaea peregra* of Boycott, Diver, Garstang and Turner demonstrated the influence of the protoplasm on the heredity of the spiral coil of the body and shell-lefthandedness or righthandedness.

These points demonstrate a certain influence of the protoplasm, but they do not prove that the organization characters are bound to it alone. Recently Hämmerling (1931, 1932) studied this point in *Acetabularia* experimentally. Young denucleated individuals could to some extent develop, but the result was closely related to the stage of development at which they were denucleated. Miss van Herwerden (1932) has rightly pointed to the possibility of an after-effect of the nucleus, which might play a part. Such an influence cannot be eliminated; for this reason we believe an *experimentum crucis* to be difficult, if not impossible.

All these reasons make us sceptical as to the dualistic conception of the hereditary factors which divide the organism into two parts, a central one formed by the archaic organization characters, surrounded by a layer of mendelizing characters (cf. Woltereck, 1934). Where can we draw an exact line between these two? There is no such line; for those characters which are the distinctions of the subspecies in one form are the characteristics of families and orders in related forms (cf. Rensch, 1933). The facts referred to by Jollos do not prove that hereditary characters are bound to the protoplasm, e.g. the well-known "Dauermodifikationen" with Woltereck's interesting experiments on *Daphnia cucullata* in Lake Nemi as illustration. They only prove a certain "influence" of the protoplasm on the result of the processes of development and organization.

Jollos thinks the occurrence of directed mutations in *Drosophila* of great theoretical significance. The results of Timoféeff-Ressovksy are contrary to them. They cannot explain orthogenetic series, for Jollos worked only with allelomorphs, and not with species and families, as in palaeontology (cf. Plate, 1932). So Castle (1934) cannot convince us that only factors in the protoplasm can explain the genetic result concerning "size-inheritance" and "sex-control"; for a simple explanation with ordinary mendelizing characters is satisfactory (cf. Green, Spöttel, 1932). Fortuyn (*Genetica*, 16, 321) described a case of mendelian segregation of quantitative characters between tribes of mice, which were closely related. The effect of blending-inheritance should result from the action of modifiers in crosses between tribes with many genetical differences.

From a theoretical point of view it is clear that the protoplasm influences the action of a gene. If we accept the genes to be units of some physical or chemical constellation, found (that is, localized) in the nucleus, they must pass into the protoplasm to activate it, as de Vries has described. So it is obvious that the processes resulting from the coöperation of gene and plasm depend on the structure of the latter; this can easily be demonstrated by the well-known influence of different temperatures on the flower colors in *Primula sinensis*. In the living cell with its continually varying processes (respiration, pH, etc.), there exists a continually changing chemical and physical plasmatic basis. This is important; for the moments of originating and action, and the time between these two points are so different for the genes in one organism, that we can distinguish some groups in relation to these differences (Haldane, 1932). It is clear that the structure of the protoplasm alters the developmental influence of a gene, even as this originates in the nucleus. The dualism, cell-protoplasm, is not a primary one, for both form a unity, the so-called "Stammsystem" of Cohen-Kysper (1933), or the "matrix" of Woltereck (Crustacea-researches, 1934). The experiments which showed that the distribution of chemical particles in the egg, in some animals, has no important influence on development and organization, support this view. When the original distribution is altered by centrifuging the chief processes of development, such as blastulation and gastrulation, are to a large extent normal (sea-urchin, Lyon; *Cumingia* and *Arbacia*, Morgan and Spooner; *Rana*, Gurwitsch.) This could account for the fact that an influence of the protoplasm or genetic results is in relatively few cases observed; on the other hand, it is not right to believe that the matrix, the spermovium, is our last basis of knowledge, and that all investigations on the influence of cytology on heredity are worthless. The atomistic conception has led us astray. According to Jennings "there is indeed no such thing as a unit character and it would be a step in advance if that expression should disappear."

Yet we believe that it is possible to maintain the genes and their significance, provided we do not start our theoretical assumptions from the genes, but from the organism itself. The genes must not be looked upon as the physiological atoms of the organism, but as its products which play a part in its support and development. They should not be regarded as present in the same form, from the incipient stage of development, but only in a potential form.

This view is closely related to the most modern investigations and suppositions in experimental embryology, in which it is demonstrated that the young embryo should be looked upon as a totality in which all characters are potentially present. Yet the development is led by a factor, that is: "the original control of differentiation in all cases appears to be exerted in relation to what may be called a biological or morphogenetic field." (Huxley and de Beer, p. 274). In the beginning there is only one field, but as development advances, it is subdivided into sub-fields, each of which controls the development of a certain part or organ of the embryo. Then there is a mosaic of fields (limbs, eye, etc.). This subdivision goes on constantly. According to Gurwitsch (1930) there is in every biological process a factor, which can be compared to the field. Every stage in such a process is a function of time and of this constant parameter, that is, the inherent invariant of the organism. Gurwitsch and his collaborators have shown that this can be applied to several kinds of processes in the development and function of animals and plants.

A short description of Anikin's investigations (1929) on the morphotrophic field of the formation of the chondral anlagen of limbs will be given. This field controls the shape of the nuclei of the mesenchyme cells. The forces acting on the surface of the nuclei radiate from the origin of the field (Feldquelle); the latter is situated in the axis of the anlage. The vectors in this field are inversely proportional to the distance between their origin and the origin of the field. With the aid of this simple law, Anikin was able to predict the shape of a nucleus at every distance from the field-origin. As figures 4 and 5 show theoretical and real shape agree in every way.

This constant factor which forms the morphogenetic field in the embryo is the gene in the adult.

Now there are several difficulties, e.g. this factor is not a chemical substance, but has a physical structure as Gurwitsch showed. Many researchers think the genes to be hormones (Goldschmidt, Huxley, and many others); but the hormones are not the cause of the organization, they only control it. Chemical substances play, of course, an important part, e.g. the mitogenetic substance through the formation of the mitogenetic rays (Gurwitsch).

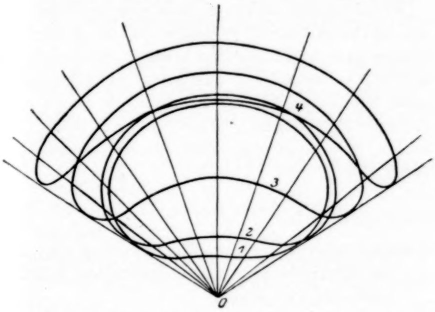

Fig. 4. The Form of the Nuclei, as a Function of the Distance between Origin (O) and Nucleus

It is premature to discuss the structure of the gene with our imperfect knowledge of this subject, but it is very important to conceive the organism as a whole and not as a colony of genes.

The former point of view has many advantages over the latter. It makes clear that different characters can be influenced by one gene or factor (polymere factors, many examples in teratology and pathology). O. Vogt's "dysnomic variability" (1929) agrees with it. Vogt and his collaborators found that the variability of characters was bound to a certain pattern (e.g. the spots on the wing-cases in beetles). They invented an intricate terminology with several kinds of variability of which the so-called "Kombinationsdysnomien" are important for phylogeny and pathology. We find a connection with heredity in "das 'Muster' ist im Genotypus fester begründet als seine Ausdehnung." Anatomical variations show us many examples of this principle. It is a well-known fact that, in most cases when there is somewhere a muscle variation in an individual, we observe in the same body-area of the other side a muscle variation which is not strictly identical with the first one. Another example may be found in the researches of Buschke (1934), who studied the ossification in the bones of twins, triplets, etc. in man, with the aid of x-rays. He could distinguish two groups of ossification-centers, a first one which follows canonic rules and is typical of the different families and a second one which does not show this regularity and varies most individually. There are plenty of other examples in anatomy and embryology. The adoption of fields superposed on each other is applied with success to some problems in neurology.

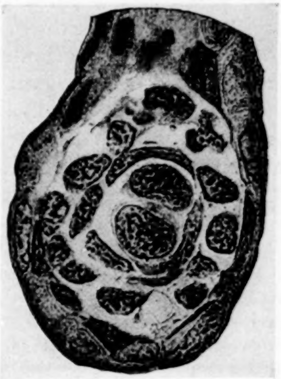

Fig. 5. Section through the Anlage of a Phalanx of Triton

Lastly we recall to mind the abovementioned fact that Muller and Painter found inert regions in the x-chromosomes. It is possible that there are localized here the causes of processes, which should not have been split up into genes, and should be of a higher order, e.g., the cause of the organization.

We gave a brief description of the possibility of a genetic organic conception. It would be characterized by a variant on the well-known sentence of du Bary: "die Pflanze bildet Zellen, nicht die Zelle bildet Pflanzen," as "the organism forms the genes, and not the gene the organism."

This synthetic view is gaining ground in many branches of biological science. In this article, especially in this section, we have tried to show that in genetics, too, such an organic conception is possible. It not only brings the facts into a better relation to each other but can also deepen and enlarge our insight into many problems.

CONCLUSION

In this article we have tried to give a discussion of the value of the gene in genetics, with quotation of some modern ideas and investigations on its morphological and physiological significance. We have tried to look upon the gene as a part of a totality and to subordinate it in an organic conception of the living creature.

At this place I wish to acknowledge my indebtedness to the criticism of Professors J. C. H. de Meyere (Amsterdam) and T. Tammes (Groningen) who were so kind as to read the manuscript of this article. Last, but not least I thank Professor de Burlet, not only for his kindness in allowing me to finish this article, but more than that for his constructive judgment.

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PROBLEMS IN THE CLASSIFICATION OF NEONATE ACTIVITIES

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INTRODUCTION

THE study of the behavior of the newborn infant has assumed an ever increasing significance during the past score of years, as biologists, psychologists and educators have striven to differentiate the instinctive from the acquired and the maturational from the learned components of human behavior. The almost insuperable difficulties encountered in attempts to effect such a separation on the adult level originally directed attention to a stage of human development wherein it was thought that all types of activity must be innate or unlearned. It was believed that an inventory of the response repertory of the newborn child would result in a catalogue or list of the raw materials from whence the adult was envisaged as arising under the influence of the environment as architect and builder. It was conceded by some writers that certain response patterns of an innate character were not to be observed at birth, but emerged at later times when the appropriate structures of the organism had matured. Others contended that even these activities were present, though in imperfect form, in the newborn baby.

The era of the biographic or diary method of determining the nature of *Homo sapiens* at birth, and his subsequent development, extended approximately from 1780 to 1910. One of the earliest and keenest biographers was Tiedemann (48), whose work gave rise to a long line of infant biographies. The greatest of all such studies was made by Preyer (40) upon his children. So accurate and unbiassed were his observations that the volumes are still of value for reference purposes. Other important biographies or diaries were made by Darwin (13), Shinn (43) and Lowden (25). The latter has had an ill-deserved obscurity.

In these biographies we may discern the rudiments of later techniques of study and of the problems which further investigators have set themselves. The early pioneers in the field of infant psychology sought to determine the instinctive and reflex endowment of human beings; they attempted to relate its manifestations to the phylogenetic past, and to trace the sequential or genetic changes from birth to childhood, or to the adult stage.

The earlier contributions differ from those made by the investigators during the past score of years in that the biographers formulated their conclusions upon the observation of a limited number of children, usually one, sometimes two, and most frequently upon their own children or those of near relatives. The reliability of their generalizations was also vitiated by their dependence upon qualitative observation and report rather than upon an instrumentalized technique for the automatic registration or recording of behavior manifestations. Their experimentation was exceedingly crude, and neither variations in type nor gradations in the intensity of external stimuli were measured or controlled. Lastly, they failed to develop suitable systems of classification which would have enabled them to digest their accumulated data and to understand the significance of such integration.

The first major experimental study of human neonates was undertaken by Canestrini (8). Employing a method that had been suggested in connection with Bechterew's (2) recommendations for the objective study of infants, he measured the effects of different types and intensities of external stimuli upon the respiration and circulation of newborn infants, automatically recording changes in these indices by means of the pneumograph, special tambours, and the kymograph. In this manner the effects of external stimuli upon two continuing vegetative activities were objectively measured. The classification of the effects is hence limited to the respiratory and circulatory consequences of stimulation, and is effected with reference to the modality of the stimulus and the nature of the sense-organs which were stimulated.

Following closely upon Canestrini's work, Benedict and Talbot (3) published their important investigations upon the metabolism of newborn infants. The metabolic indices provided evidence of activity changes of the organism, as did the crib-recorder records obtained by these workers on the periodicity of general motility. It is indeed unfortunate that for almost two decades this important contribution escaped the attention of practically all psychologists. The objective study and analysis of the nature of the human infant would have been furthered immensely if this work had been more widely known.

As it happened, the greatest impetus in the English-speaking world to a renewed and intensive examination of the neonate equipment was provided by the scanty and relatively haphazard experimentation of Watson (50) and his associate Blanton (6); work which served as the point of departure for intense and vigorous controversy upon the nature and number of innate instincts and emotions. Watson sought to determine their number as a basis for subsequent behavior manifestations to be induced largely by environmental conditioning. His service to child psychology in challenging the uniqueness and innateness of a host of instincts and emotions limited, for the most part, by nothing more than the possibilities of our vocabulary, cannot be overlooked, even though some of his generalizations and experimental findings have been unconfirmed or have proven inadequate.

The criterion of the innateness of behavior, namely, its presence at birth, did not remain unchallenged. There developed a desire to learn the antecedents of the neonate repertory, in other words there was a demand that the history of particular responses be chronicled from their fetal beginnings. Preyer was a pioneer in this field, but the first comprehensive studies of prenatal development were carried out by Minkowski (28) (29), and the ablest review of the history of such investigations of fetal behavior has been written by Carmichael (10). Minkowski, by qualitative methods investigated the reactions of fetuses delivered by Caesarean section when abnormal maternal conditions necessitated the termination of pregnancy. In this way he was able to trace the genesis of particular responses in relation to the maturation of the nervous system. At about the same period Bersot (4) (5) made an intensive sequential study of the plantar response in man, and employed statistical devices to express its changing manifestations and variability.

From these researches it has become

apparent that the old conception of fixed, discrete reflexes must be abandoned in favor of the view that the early stages of human behavior show, not specificity, but generalization; and that specificity of function comes as the result of individuation through growth processes and through environmental modifications. At first the number of action segments brought into play by stimulation of most sense-organs is very great. An 'action segment' of the organism is, in most instances, a moveable part whose boundaries are the points of articulation. Thus the leg as a whole is a gross segment subdivided into a number of smaller segments. With progressive maturation the stimulogenous zones tend to become smaller and the responses to be more restricted or localized.

In the previous century it became apparent that there exists in the infant a definite order of development along various axes of the body. Buck (7) and others observed what they termed a development from "fundamental to accessory" in the responses of the body segments. In the present century this has received experimental confirmation in many investigations upon lower animals by Coghill (12) and his associates, and it is now termed the 'proximo-distal course of growth.' The direction of growth along the major axis of the body—the cephalo-caudal—has also received considerable attention. These axial trends of development in human beings have been studied by Irwin (22) (24), Shirley (44), and Marquis (27). Shirley has built up a sequential or genetic classification upon this foundation and its implications for general psychology have been expressed by Goodenough (18).

The research program initiated by Weiss and his associates Pratt, Nelson, and Sun (39), Irwin (21), and Marquis (26) embodied a frontal attack upon the major problems of neonate development. New and improved techniques were devised to give objective records and to control the conditions of stimulation.

An analysis of the researches in infant psychology during the past twenty years indicates a need for more systematic classifications of the known responses of the newborn child if a better understanding of the neonate organism is to be attained. With few exceptions the summaries of behavior at this developmental stage embody mixed principles of classification: some responses are classified according to stimulus and receptor loci; some with respect to whether they are innate or acquired; others according to their effects or purposes; and some with reference to their developmental aspects, antecedent and subsequent. Frequently the classification represents primarily an enumeration or a cataloguing of responses. The summaries of Blanton (6) and Dennis (14) illustrate the latter type; both writers classify largely according to the site of movements. The summary by Hurlock (20) is still less systematized.

It would appear self-evident that a given summary should employ some consistent principle of selection and organization. The basis used must depend upon the aim of the particular inventory; indeed, no one mode of classification will serve all purposes.

In the succeeding portion of this article an attempt will be made to outline the principal systems of classification, to state the contribution made by each to the understanding of the newborn organism, and to portray the advantages and disadvantages of any particular set of categories.

CLASSIFICATION ACCORDING TO STIMULI AND SENSE-ORGANS

One of the oldest and commonest systems of classification of human behavior makes use of the various modes of energy which serve as stimuli, and utilizes the sense organs as fixed reference points. Physiology and psychology alike have utilized this scheme. The summaries by Peiper (31) and by Pratt (33) are type examples of it in the field of neonate behavior.

The major advantage of this type of classification is that its reference points are relatively well-defined and constant. The stimulus may undergo certain fluctuations or modifications but the sense organ remains a stable reference point. This makes it feasible to pass from a point in one cross-sectional plane in the developmental continuum to the same point in a preceding or succeeding cross-section, and thus to effect a comparison between the behavior at different levels of development.

As an illustration, we may present a stimulus of a certain intensity and wavelength to the visual sense-organs at the late fetal or early neonatal level and thus evoke circulatory and respiratory changes, blinking (visuopalpebral reflexes), pupillary reflexes and frequently Moro's Umklammerung or clasping reflex (a complex response involving a start or jerk of the body and an extension and abduction of the extremities followed by flexion and adduction), and like responses. Later, during the cross-section of the suckling stage, the same stimulating conditions fail to release the Moro response; in fact persistence of this response has a pathological significance. At a still later period of development (at about 5 years C. A.) a new response has appeared and the child, if English-speaking, may say "red." And again, the time may come when the same individual when confronted by this stimulating condition, considerably modified, will put his feet on the clutch and brake pedals of the automobile he is driving. In the latter cross-sections the new responses mentioned must be learned responses even though a definite degree of maturation was prerequisite for such acquisition.

The constant reference points and the ease with which the classification is made on this basis have contributed to its extensive use and still commend it. It lends itself readily to normative *sampling* and is therefore excellent for clinical purposes.

The major defect of such a system is that it tends to stress isolated, part activities and stimulus-receptor aspects rather than the *integrated* organism in action.

CLASSIFICATION ACCORDING TO ONTOGENETIC CAUSAL FACTORS: MATURATIONAL VS. ENVIRONMENTAL

For the educator the differentiation of nature from nurture, of the innate from the acquired forms of behavior has, mistakenly perhaps, assumed transcendent importance. One may incline towards the predeterminism of a Morgan (30) or the epigenesis of a Child (11). In child psychology the two extremes are exemplified by Gesell (15) and Watson (51). The latter holds that the characteristics of a given individual are the result of combinations and organizations of innate behavior produced by environmental factors. Gesell would assign the secondary rôle to the environment for he maintains that it is the nature of the organism which determines or sets the limits of possible environmental modifications of the organism.

The attempt to distinguish the unlearned from the acquired forms of behavior has led to a continuous ontogenetic regression in the search for innate behavior. At first, presence at birth served as the chief criterion, then the reference time was pushed back into the prenatal stage and still there arose critics such as Givler (17) who pointed out that even in the prenatal environment the possibilities of exercise and learning could not be ignored.

Gesell and Thompson (16) attacked the problem by means of the 'co-twin control;' the assumption being that identical twins present the same possibilities of behavior, and that if heredity and maturation are most important the twins should have the same type of responses even though their environments are different. This seems to be an unimpregnable position but Richards and Irwin (41) have questioned the assumption that identical twins are completely 'identical' and from the other angle one may ask whether the environmental differences are significant. Perhaps we are only witnessing the consequences of Child's 'standard environment' when we observe the behavior repertory of the newborn infant.

In the light of these difficulties the value of a classification in terms of 'innate' or 'acquired' becomes dubious indeed. An illustration will serve to show that crucial experimentation will be necessary before any given response may properly be classified under these categories. The newborn infant does not possess a protective wink reflex to the approach of an object to the eyes, but at about 60 days of age such a reflex makes its appearance. Is it the result of maturation or is it a learned response? Watson held to the last-mentioned possibility, and indeed this seems quite plausible when one notes that the requisite factors for the establishment of a conditioned response are present. These are: a stimulus which does arouse the response in question (contact stimuli provided by the infant's hands touching the eye-lids, lashes, etc. and causing the lids to close) preceded by visual stimuli from the approaching hands. Further repetitions of this sequence eventually result in the response of winking to the approach of an object. This explanation seems at first to be satisfactory and yet there are animals which have such protective wink reflexes at birth with no possibility for such a process of conditioning in the fetal stage.

Among classifications of innate reflexes Warren (49) has given one of the most compact.

TELEOLOGICAL CLASSIFICATIONS

Closely allied historically to the view that responses may profitably be classified as innate or acquired is the belief that they may be divided into those which are purposive, i.e., which effect certain results upon the organism or upon the environment and in general work towards maintaining the integrity of the individual, and into those which serve no apparent ends. This, therefore, gives rise to a classification of responses in terms of their effects rather than in terms of reference to organismic factors either genetic or topographical in nature.

There are a number of telic rubrics of which the oldest and most widely used is one which interprets responses in terms of their utility as mechanisms of defense or protection. When a particular response in the ontogenetic present can be so classified only with strained logic a solution is sought by referring the teleological consequences to the phyletic past. For this reason the doctrine of recapitulation is almost invariably linked with the notion of the purposive character of neonate behavior.

Basically a defense response consists of one of two types of movement with reference to the external stimulating situations: (1) repelling the stimulating source and (2) withdrawing from it. When the movements are very ineffective, as objective examination often finds them, their teleological functions are supposedly manifested in the *intent* of the movements rather than in their *execution*.

A few responses of the newborn infant will serve to illustrate the criteria for such a classification and to make apparent some of its glaring weaknesses. First, let us consider certain responses which have been definitely termed movements of defense. Watson (50) reports that holding an infant's nose will arouse the emotion of 'rage,' and that some of the movements involved are defensive in character. The results obtained by Pratt, Nelson, and Sun (39) from such stimulation fail to support Watson's findings as to the existence of a general, emotional pattern of response. True, there is a relatively limited amount of movement on the part of the trunk and limbs in a few cases, but the prevailing mode of reaction is an arching of the back and a backward movement of the head. Theoretically this response might be considered defensive, in that its "intent" is to withdraw from the source of stimulation. However, such an interpretation in no way accounts for movements of the head in one particular direction rather than in another. Movement from side to side would be just as useful. Still more purposeful would be definite movements of the hands towards the nose.

The Shermans (42) have stated that a firm pressure exerted upon the chin releases defense responses which are characterized by movements of the arms and hands, so that the experimenter's finger is touched. They report that the efficiency is not high at first, but that it improves rapidly with increase in age. The experiment should be repeated, with better controls, for the writer has been unable to confirm it in experimentation upon quiescent infants.

With respect to the bending back of the head it is interesting to observe that stimulation of the forehead by a cold temperature cylinder, or of the eyes by a flash of light (Peiper's *Augenreflex auf den Hals*) will all produce the same reaction, namely, a withdrawal or attempted withdrawal from the source of stimulation.

Akin to these are the pupillary reflexes, the *Rückgrat* (Galant) and abdominal reflexes, and the visuopalpebral or blinking response. All of these appear plausible as protective reflexes, but we must stretch the point greatly if the cochlear-palpebral response is to be interpreted as "defensive." Recourse must be had to phylogenetic history if such responses are to be fitted into the present category.

Other responses of protective nature, if viewed as atavisms, are the grasping reflex and Moro's clasping reflex (as elicited by jarring, loss of support, and similar stimuli). These are alleged to have had a survival utility in an arboreal past of the human race.

Lastly, the plantar response has been alleged to be a movement of defense. Babinski (1) has claimed that not only is the triple retraction of foot, leg and thigh 'defensive through withdrawal,' but that the plantar flexion of the toes during the first hours after birth is defensive, in that it represents a *counter-offensive*. The subsequent events are strange indeed, for thereafter the toes show plantar extension upon plantar stimulation, and the response must now be 'defensive by withdrawal.' Still later, at about the age of one year, the toe response is again one of flexion (counter-attack). This example, as well as others which could be cited, suffices to cast doubt upon the value of the term, 'defense reflex,' as a descriptive category in the classification of neonate behavior.

Additional evidence (36) which militates against the term 'defensive' as applied to the plantar response is obtained if one varies the site of stimulation and observes the effects, if any, upon the aroused responses. Stimulation of the plantar surface of the foot in the traditional fashion evokes a flexion of the foot, and hence brings a withdrawal of the member from the source of stimulation. Now, if the top (dorsum) of the foot is stimulated in the median line, the consequence is again a flexion of the foot at the ankle—but in this case the foot does not move away from the stimulus but rather maintains contact with it. So without altering the response we change its character of 'defense by *withdrawal*' to 'defense by *attack*' by merely changing the site of stimulation! The allegedly defensive features of many reflexes will probably bear scrutiny no more successfully than does the plantar response.

Inasmuch as certain responses do perform somewhat recognizable rôles in the life economy of the child, classifications such as the vegetative must be entertained. The utility of responses which participate in the basic activity of alimentation is granted by hypothesis. It is slightly more difficult to discover any maintenance value in some of the respiratory and circulatory changes which are brought about through external stimulation.

Thus far we have evaluated the 'purposive' behavior; now we turn to the 'non-purposive.' For the newborn infant the item which is usually entered under this heading is the 'random' or 'spontaneous' activity. However, these teleological terms came into use when the nature of such behavior was undetermined. Thanks to the researches of Benedict and Talbot (3), of Carlson and Ginsburg (9), Taylor (47), and Irwin (23) we are now beginning to have insight into this aspect of behavior and can interpret it in purposive terms just as successfully as we may interpret the more specific responses. The necessary conditions for this normal 'random' activity are either external, such as continued thermal or noxious stimuli, or internal, developing from changes which take place along the alimentary tract. Talbot (46) considers the general activity consequent to lowered environmental temperatures to be a type of temperature-regulating mechanism. This being true, the activity may be considered directly purposive in a vegetative sense. Yet when we consider the same behavior as an accompaniment of hunger contractions of the stomach, there is nothing of immediate telic value to be discerned. Of course, as a 'drive' manifestation, the increased activity may be attributed a phylogenetic though not an ontogenetic value. Further, one may term it 'purposive' because of the effects that it may exert upon the social environment.

Notwithstanding all of this, it is very doubtful whether much is to be gained by attempting a teleological classification of neonate behavior. The 'present utility' of a response may be of great importance and interest, but can well be treated in other and in more satisfactorily based types of classification.

CLASSIFICATION ACCORDING TO DEVELOPMENTAL CHARACTERISTICS OF RESPONSES

In theoretical (35) and experimental (36) (37) (38) papers the writer has attempted to develop a system of classification which will portray behavior changes in their organismic setting. He believes that the sequential pursuit of certain responses is only a partial approach to a truly genetic psychology, and is in its way just as arbitrary and fractionated as is a stimulus-receptor classification. Norms may be established for manipulation, locomotion, speech, and the like, but the individual then appears as a conglomeration of different streams of action.

The writer agrees with Bersot (5) that responses which are considered apart from the remainder of the behavior of an organism must then lose their principal significance. How, then, may human behavior be classified so as to present adequately its present, past, and future interrelations? What type of classification will sweep through and include such phenomena as the sequential development of particular responses; the individuation of behavior along the various axes of the organism; the changes in the reflexogenous zones; and changes in the types and range of stimuli, in the case of learning, of fatigue, and in the responses which occur under different physiological states and under pathological conditions?

In spite of certain difficulties it seems feasible to classify behavior as 'specific' or as 'generalized' in respect to other responses in the same cross-sectional (i.e., at the same age level) plane, or in respect to its preceding or succeeding phase in the longitudinal (i.e., at different age levels) plane.

Obviously such relativity precludes a simple division of responses into two groups. Actually, what is required is a quantitative expression of stimulus-receptor-effector relations at different age levels and under various physiological conditions of the organism. When this is accomplished we shall have expressed the varying degrees of 'specificity' of the response repertory of the infant. It will then be easy to determine whether one response is more 'specific' than another by comparing their respective places in our table of quantitative values. Some may object that such a classification stresses the quantitative features but neglects the qualitative aspects such as the type and sequential order of participation of action segments in a response. In reply it may be said that what we have termed the quantitative features manifest a fairly definite order of development whereas those we have termed 'qualitative' appear almost saltatory or emergent in character. For example, the change from plantar flexion to plantar extension of the toes. It is true that there is a transitional stage, but the transition period is marked by the appearance of *either* flexion *or* extension. The same action segments are involved but the character of movement varies according to the nature of the innervation. But this fact need not be lost sight of, in our classification of activities, even though it cannot be equated quantitatively. The difficulty here is that our analysis of movements stops short at action segments rather than muscle groups and, more important still, it does not deal with the order of events in the nervous system which are responsible for the alteration in the type of movement of a segment.

There are three characteristics of behavior mechanisms which must be taken into account if a comprehensive classification of this type is to be made. These are: (1) the relative extent of the stimulogenous zone; (2) the number of different types of sense-organs whose stimulation will release essentially the same pattern of response; (3) the relative degree of segmental involvement or participation in a response.

Without touching upon the details of the scheme for representing quantitative degrees of specificity the possibilities of such a classificatory system may be made apparent by analyzing a few responses. Let us consider characteristic (3) in both the cross-sectional and the longitudinal views of the plantar response. Considered cross-sectionally, a response which involves the toes, foot, leg and thigh is 'generalized,' *in the sense of segmental participation*, if compared with a response of the big toe alone, but is 'specific' in comparison with a response which involves contralateral as well as homolateral activity of the inferior extremities. Again, this latter response would be 'specific' in comparison with Moro's reflex. In the longitudinal plane at first there is greatest 'generalization,' followed by the progressive restriction of segmental participation, so that when complete individuation arises there may be movement usually of the big toe alone. Under certain physiological or pathological conditions there occurs a reversion to the earlier and more generalized forms (38) of the response.

The orientation and sucking reflexes which comprise the food-getting response afford an excellent illustration of characteristic (1). At birth, the reflexogenous zone extends over the lip and cheek areas, although even at that time a differential sensitivity may be demonstrated. With increasing age the frequency of response to cheek stimulation decreases—i.e., the reflexogenous zone becomes restricted (39). On the early neonate level the reflexogenous zone of the plantar response is more extensive or generalized, that of the palpebral (contact-aroused) more limited or specific, than that of the orientation and sucking reflexes.

Characteristic (2) (the number of different types of sense-organs the stimulation of which evokes the same pattern of response) is exemplified in the most generalized sense, in that stimulation of practically all kinds results in respiratory and circulatory changes; and this is also apparent in the release of the Moro reflex through auditory, visual, static and probably through other forms of stimuli. On the other hand, the area whose stimulation will start the hiccup response (32) is well restricted to one bodily region.

Again, considered upon the cross-sectional plane, in the case of the Moro response we find the greatest involvement of the organism in the response to the first of a series of auditory stimuli, followed by a decrease in segmental participation in the responses to the further stimuli of the series (34). This phenomenon is typical of inhibitory mechanisms.

Finally, in the process of learning, such as in mastering the art of writing, Steinmann (45), and Gottstein and Gottstein-Schenck (19) find that initially generalized associated movements (Mitbewegungen) are the rule, and that the younger the child the more pronounced the intensity and the spread of the associated movements.

In the foregoing examples we have attempted to outline the principal features of a comprehensive classification of neonate behavior. The ordinary classification of responses, according to stimulus-receptor reference points, leads almost invariably to the impression of extreme multiplicity of responses, for almost every stimulus-receptor reference point gives rise to another name for the response despite the fact that in patterning of segmental participation it remains unchanged. A striking example of this is furnished by what is usually termed the plantar response. According to the cutaneous area stimulated we have 'Schaffer's reflex,' 'Gordon's paradoxical reflex,' 'Oppenheim's reflex,' etc., all of which refer to essentially the same response. Similarly, the pattern of movements which we have referred to as the Moro reflex (originally so-termed when the response is evoked by jarring the infant) has been called the 'primary emotion of fear,' the 'fear' response, the 'shock' response and the 'startle' reflex when elicited by auditory stimuli. Further, the throwing back of the head to various types of stimulation promises to develop a varied terminology according to the stimuli employed.

The comprehensive system of classification, on the other hand, presents a segmental analysis of a response and lists the types of stimuli and the sense-organs whose stimulation will bring it about. From this one tends to derive a picture of organismic activity rather than of highly fictionalized part activities. But its greatest advantage is in providing a quantitative expression of specificity, thus making it possible to compare degrees of specificity at different levels in the genetic development of a response, or to effect such a comparison between different responses at the same age period. Further, it enables one to follow both the quantitative and qualitative changes contingent upon particular physiological states of the organism and upon those environmental influences which produce learning.

In conclusion, the principles of classification employed seem to have a truly genetic significance and are inclusive enough to furnish insight into both the cross-sectional and the longitudinal interrelations of human behavior.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will frequently appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to Dr. Raymond Pearl, Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *1901 East Madison Street, Baltimore, Maryland, U. S. A.*

BRIEF NOTICES

EVOLUTION

HEAD, HEART AND HANDS IN HUMAN EVOLUTION.
By R. R. Marett. Hutchinson's Scientific Books, London. 10s. 6d. net. 8½ x 5½; 303; 1935.

The author, Reader in Social Anthropology at Oxford, is well known for his studies in anthropology and primitive religions. In this volume he discusses the three fundamental ways of organizing human experience—by means of the head, which provides categories or leading ideas; by means of the heart, which finds its chief expression in religion; and by means of the hands, which enable man, the manipulative animal, to abound in arts and crafts. The four sections of the book deal with the sociological outlook; pre-theological religion in general; pre-theological religion—particular illustrations; and primitive technology (arts and crafts of prehistoric and primitive man). Throughout the volume the writer argues for a better understanding of the underlying motives of customs and behavior. Acquaintance with different cultural connections helps the mind to detach essential values from their casual context and to measure them by the sole value of their intrinsic worth. Since on the economic plane we are gradually moving towards a relative uniformity of conditions and, even in its physical aspects, human life throughout the globe is threatened with a certain stupefying sameness, the writer argues that the true work of man lies in "giving free scope to our natural variability on the side of the spirit." Tolerance of the playworld of the savage and of many of his customs which have always been quite healthy in their moral tone, will not let "his future be rendered as dark as that of many a drudge of civilization." Most of the material in this volume has either appeared in print or been given in the form of lectures. The work is indexed.

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HEREDITY AND THE ASCENT OF MAN.
By C. C. Hurst. The Macmillan Co., New York. $1.50. 7¼ x 4⅞; ix + 138; 1935.

This is an admirably clear exposition for the general reader of genetics and its bearing on the problem of evolution. In Hurst's presentation the emphasized factors of evolution are mutation and hybridization rather than natural selection. Of particular interest is the account of the experimental creation of new species and recreation of known species.

> These experiments demonstrate that gene mutations and transmutations may be either so minute as to be of slight taxonomic value, they may be small or varietal, or they may be large and specific, generic, tribal, or even familial and subordinal. . . . It is interesting to note that when a high group character like the two-celled ovary mutates it behaves like an ordinary varietal or Mendelian character. This fact, which has since been confirmed in generic and specific

characters in roses, shows that the higher taxonomic characters are determined by genes as well as the lower varietal characters.

In the last chapter the author leaves the solid ground of experiment and soars into the thin air of speculation. Since in the course of creative evolution mind has gradually increased in influence compared with matter, he extrapolates this trend to the conclusion that, with the help of a suitable eugenic program, "successors of Man may be evolved in whom the influence of matter has been almost, if not entirely, obliterated. In these conditions a less material or almost immaterial type of being might arise, utterly different from the present human species, scarcely human save in mind and intellect and on a higher intellectual plane. Such an independence of matter might enable the more adventurous spirits among our faraway descendants to leave the earth and to visit, and maybe occupy, other planets or stellar systems of our universe or even other universes if they exist."

* * *

THE CHANGING WORLD OF THE ICE AGE. *By Reginald A. Daly. Yale University Press, New Haven.* $5.00. $9\frac{1}{4}$ x $6\frac{1}{4}$; xix + 271; 1934.

A highly interesting book not only to students but to lay readers as well. The material was prepared originally for the Silliman lectures. Expanded in book form the author has included many tables, quantitative data, footnotes and references for advanced workers in this field, but the general reader will find little that is formidable. The latter part of the volume is devoted to the author's theory of the formation of coral reefs. He believes their origin was made possible by the Pleistocene changes of climate and the associated swings of sea level caused by the growth and melting of land ice. The arguments supporting this theory are discussed in great detail. The many excellent diagrams, charts and figures form a valuable part of the work. A detailed index is included.

GENETICS

Теоретические Основы Селекции Растений. Том I. Общая селекция растений.

Н. И. Вавилов, Главный редактор. Государственное издательство сельскохозяйственной литературы, Москва-Ленинград. 20 руб.; xx + 1043; 1935

[THEORETICAL BASIS OF PLANT BREEDING. *Vol. I. General principles of plant breeding. Edited by N. I. Vavilov. State Publishing House for Agricultural Literature, Moscow-Leningrad.* 20 roubles. 7 x 10 inches; xx + 1043; 1935 (cloth)].

This is the first volume of an excellently published and thoroughly documented monograph on plant breeding. It consists of a number of chapters written by different members of the Research Institute for Plant Breeding in Leningrad and edited by Professor Vavilov. Many of the results reported appear here for the first time, and a good use is made of Russian and foreign bibliography of the subject. As stated in the preface:

> The first volume treats general problems and methods of selection as: geographic basis in selection, the principles of classification of economically important plants, the theory of mutations and of hybridization, the application of cytological, anatomical, biometric, biochemical and physiological methods in selection. Attention is paid to the methodology of selection for immunity against diseases and for cold- and dry-hardiness. . . . All chapters have been reported and criticized before the Scientific Council of the Institute, and are here published in the form modified by discussion.

The volume consists of 5 parts including 29 papers written by 27 authors. Space does not permit us to mention all of them by name. As a matter of illustration we may take a paper by Professor Ivanov, "Biochemical basis of plant breeding." In his tables on variability in chemical composition of plants as related to race and environmental conditions he gives a great deal of hitherto unpublished data. For all plant breeders who read Russian this is a very valuable reference source.

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GENETICS. *By H. S. Jennings. W. W. Norton and Co., New York.* $4.00. $8\frac{1}{2}$ x $5\frac{3}{4}$; xii + 373; 1935.

Dr. Jennings has written a clear and complete exposition of the fundamentals of genetics. This book, though intended for the layman, is far superior to the general run of science popularizers. The subject is presented in an orderly manner and at all times the reader is made aware of whether the author is discussing facts or theories. This is especially evident in the latter part of the book where the author examines the problems of heredity versus environment and of genetic variations. Characteristic is the concluding paragraph:

> On the other hand it may turn out that gene mutations of the sort thus far observed are not the material of progressive evolution. It may be that we have not yet recognized the actual steps in progressive evolution, and that when these come clearly into view, it will be found that they are not the result of action of destructive agents, nor connected with injuries to the genetic system, but rather a resemblance to the changes of growth. These questions must be reserved for the future.

The bibliography is sufficient and in the reviewer's opinion this book could very well serve as a college text.

* * *

REPORT OF THE 11TH ASSEMBLY OF THE INTERNATIONAL FEDERATION OF EUGENIC ORGANIZATIONS. *Conferences July from 18th to 21st (inclusive) 1934, Waldhaus Dolder, Zurich, Switzerland.*

Art. Institut Orell Füssli, Zürich. 10 Swiss francs; copies to members and correspondents of the International Federation of Eugenic Organizations at the office, 443 Fulham Road, London—3s. 6d. prepaid. 9¾ x 6⅝; 84; 1935 (paper).

A report of papers read and discussed at the 11th Meeting of the International Federation of Eugenic Organizations. The introductory paper by Professor Rüdin, president of the Association, outlines the work of a German committee, aided by the Rockefeller Foundation, formed for the purpose of studying racial predisposition in Germany in relation to various mental diseases independent of asylum and clinical treatment The second paper by Professor Berry of England deals with the diagnosis and grading of oligophrenics. Dr. Mjöen of Norway discusses his methods for determining musical capacity. The fourth paper deals with personality and the present unsatisfactory state of the science. The fifth paper on racial psychology by Steggerda, deals with further attempts to measure personality. The fourth section of the conference was devoted to papers on twin work and the last part of the conference to a discussion by representatives from various countries concerning the status of eugenics in their respective countries.

* * *

DIE BLUTSVERWANDTSCHAFT *im Volk und in der Familie. Ein Beitrag zur menschlichen Lebenskunde (Anthropologie).*

By Walther Jankowsky. G. Schweizerbarth'sche Verlagsbuchhandlung (Erwin Nägele), Stuttgart. 7.20 marks. 9¼ x 6; viii + 166 + 6 plates; 1934 (paper).

The central problem of this book is that of resemblances in appearance, not only between members of a family but also between individuals who are not known to be related. In an effort to state and clear up this problem somewhat Jankowsky ably discusses the concepts of blood relationship, resemblance factors, the biological character and significance of the phenomena involved, individual heredity, pseudo-resemblances, and differences in members of the same family. He is cautious in formulating conclusions. A point of interest is the degree to which significance is to be attached to resemblances between unrelated persons on the theory of chance, and with special reference to conditions of descent within a given population.

This is a thought-provoking contribution, of interest to the ethnologist and student of human genetics. It contains a bibliography and is illustrated.

* * *

ANLEITUNG ZUR ERBBIOLOGISCHEN BEURTEILUNG DER FINGER- UND HANDLEISTEN.

By Georg Geipel. J. F. Lehmann, Munich. 5 marks (paper); 6.20 marks (cloth). 8⅞ x 6⅛; 80; 1935.

In this hand-book the author presents in turn a classification of finger prints and palmar friction skin patterns based on the Galton-Henry studies; a method of taking and classifying prints; and a discussion of the inheritance of patterns, based on his own work on 1500 pairs of twins, and that of Bonnevie. Several examples of establishing paternity by comparison of finger-prints are cited. The book is intended for the use of anthropologists, jurists, criminologists, biologists, and physicians. It is illustrated and has a short bibliography.

* * *

PHYSIOLOGIE DU DÉVELOPPEMENT ET GÉNÉTIQUE. *Actualités Scientifiques et Industrielles, 254. Exposés de Biologie (La Génétique et les Problèmes de l'Évolution), I.*
By N. K. Koltzoff. Hermann et Cie, Paris. 12 francs. 10 x 6½; 56; 1935 (paper).

An interesting theoretical discussion of the processes of fertilization, cell division and early embryonic development, well written but distinctly speculative in character. This volume starts a new sub-series of the *Actualités*, under the general title *Exposés de Biologie*, to be edited by Professor Koltzoff. We shall await with keen interest further numbers.

* * *

GENERAL BIOLOGY

DIE MASCHINE UND DER ORGANISMUS.
By Hans Driesch. Johann Ambrosius Barth, Leipzig. 4.50 marks. 9⅛ x 6⅛; 76; 1935 (paper).

From certain points of view a living organism may be regarded as a machine. From the standpoint of kinetics both the steam engine and the horse are machines which transform chemical energy into mechanical energy. The question is whether all aspects of the activities characteristic of the living organism can be interpreted in mechanistic terms. If a fertilized ovum in its early stages of segmentation is cut in two, each half develops into a complete organism. Driesch in his previous writings has concluded that this process cannot be purely mechanistic, that a non-mechanical agent, an entelechy, must direct it. In the present book he extends his argument to behavior. This is not an invariable linkage of a certain detailed response to a certain stimulus; different responses, which attain the same end in different ways, may be called into action. If I lose my right hand I learn to write with my left. Here again Driesch concludes that a purely mechanistic interpretation is inadequate. Nerve conduction and muscle contraction may be purely mechanical processes, but there must be an entelechy to initiate the impulse over one nerve rather than another. An appendix contains Driesch's reply to the criticisms of Schlick and Carnap.

* * *

Анаъиоз.
П.Ю.Шмидт. Государственное издательство биологической и медицинской литературы, Москва-Ленинград. 5 руб. 65 коп.; 296; 1935.

[ANABIOSIS.
By P. J. Schmidt. State Publishing House for Biological and Medical Literature, Moscow-Leningrad. 5.65 roubles. 5 x 8 inches; 296; 1935 (cloth)].

The essential structure of living matter and the principles of operation of metabolic machinery are at present very imperfectly understood. Such attacks as Needham's valuable writings on the dissociability of the fundamental processes in ontogenesis are few in number, and the whole field lies open for intensive theoretical and experimental research. The attempts to stop life for a while tried in the "anabiotic" experiments can undoubtedly throw some light on metabolic machinery, and in this book a fascinating account is given of such attempts.

The book consists of Prolegomena, Epilegomena, and four chapters: (1) Latent life, (2) Anabiosis under desiccation, (3) The action of high and low temperatures on life processes, and (4) Anabiosis under freezing. Concerning the very possibility of the complete cessation of life processes the present author concludes:

> All the reviewed experiments on the simultaneous action of low temperatures and more or less complete desiccation, and especially under complete exclusion of the oxygen of the air, show definitely that in some moss-inhabiting animals a reversible cessation of life has been actually observed. In these experiments any traces of metabolic processes are absolutely impossible, as no chemical reaction could go on at a temperature only a few degrees above the absolute zero, and gases participating in respiration are in the solid state.

There are perhaps some specific adaptations in these moss-inhabiting animals, and in many other cases, as Kalabuchov has recently shown, no such complete cessation could be experimentally realized. Schmidt therefore concludes:

> We are at present only at the very beginning of the scientific study of anabiosis, which appears to be much more complicated than originally supposed. The main trails for research are already more or less clear, but a great deal of work and energy should be spent until the whole phenomenon will be mastered and used for our own ends.

This is a valuable review, and so far as is known no such book is available in any of the leading European languages. Anabiosis does not yet attract the attention which it undoubtedly deserves.

* * *

Biological Processes in Tropical Soils *With Special Reference to Malaysia.*

By A. Steven Corbet. W. Heffer and Sons, Cambridge. 7s. 6d. net. 8½ x 5⅜; xiv + 156; 1935.

The great diversity of climatic conditions throughout the tropics produces a wide variety of problems, but throughout the hot, wet equatorial belt conditions are so similar that there is much in this volume that is applicable to regions outside of Malaysia. Due allowance must be made, however, for variations in flora and fauna. The author, chemist and biologist at the Rubber Research Institute of Malaya, has written primarily for agricultural chemists, but planters and foresters in tropical countries will find the volume highly useful. Mr. Corbet states that the whole process of formation and decomposition of soil organic matter in the humid tropics seems to be based on (a) Jenny's law that the "nitrogen and organic matter content of the soil varies inversely with the soil temperature and the amount of solar radiation received," and (b) "At temperatures below 25°C. there is an accumulation of organic matter in the soil but, at temperatures above this, humus decomposition outpaces its formation." These laws he discusses at considerable length. In the first chapter such questions are considered as the burning of cleared land, leguminous cover plants, natural covers, the effect of fertilizers on the soil, and garden soils. The volume is fully documented and in an appendix contains sections on (I) Standard methods employed for the examination of soils, and (II) Classification of bacteria. There are also illustrations, figures, charts and graphs, and author, subject and plant indexes.

* * *

Problems in Soil Microbiology.

By D. Ward Cutler and Lettice M. Crump. Longmans, Green and Co., New York. $3.20. 8⅝ x 5½; vii + 104; 1935.

The purpose of this book is to show

> . . . that from the biologist's viewpoint the soil is an eminently suitable home for living organisms and that, through the long ages of evolution, a population has been selected which is, on the whole, so unspecialized that almost any substance which finds its way into the soil, either naturally or in the course of modern agricultural practice, will eventually become incorporated into the general soil economy.

The book contains chapters on the following topics: the suitability of the soil for micro-organisms; the bacterial population of the soil under field conditions; the relation of the soil bacteria to nitrite; carbon dioxide production by soil; the growth of protozoa in pure culture; the behavior of protozoa in soil, and the interactions between the soil organisms. There is an index and a bibliography.

A significant piece of work which should prove interesting and stimulating to the general ecologist. Any careful investigation, such as this one, on the structure and analysis of a biotic community is a welcome addition to biological literature.

Alters-Forschung. *Untersuchungen und Berichte über Lebensdauer, Altern und Tod. 1. Jahrgang.*

Edited by Josef Kluger. Josef Kluger, Gartenstrasse 135, Wünschelburg-Heuscheuer. 3 marks. $9\frac{1}{4}$ x $6\frac{5}{8}$; 40; 1935 (paper).

The first volume of a periodical devoted to a resumé of recent thought and study of longevity. There are six different articles all apparently written by the editor who is at the same time sole contributor to Volume one. The first article is about some of the more obvious phenomena of old age, following which is a chart of the various branches of science which contribute directly or indirectly to our knowledge about age. A few pages are devoted to two articles: (1) Chief characteristics of age as seen on the skin; and (2) Hardening of the arteries as evidenced in old age. The editor then lightens the tone of the magazine by inserting a few quotations from famous people who have lived to an old age and reflected some upon it. The last two articles are about grey hair and long life among animals other than man. The magazine winds up with seven life histories, each a few lines long, five of whom are Germans 80 or over now enjoying good health, (6) an old hen aged 21 years, and (7) a rose bush blooming healthily since 1788. There is a brief reference to new publications on longevity.

* * *

The Teaching of Biology.

By Mary E. Phillips and Lucy E. Cox. University of London Press, London. 4s. 6d. net. $7\frac{3}{8}$ x $4\frac{7}{8}$; viii + 155 + 4 plates; 1935.

This little volume is written by two women who have had experience in the teaching of biology to children, with the object of presenting to other teachers methods they have found most effective in creating a wide awake interest in biology and nature. The book is divided into three sections of about equal length. The first, entitled "The general principles that underlie biological teaching," is punctuated with quotations on child psychology from various authors and gives simple answers to the questions of what are the aesthetic, ethical, logical and practical values of biology. Sections 2 and 3 have to do with general and special methods of directing and teaching biological work among children in age groups varying from the "under fives" to the sixteen year olds. Stress is laid on the great importance of observation and experiment and the recording of results in the form of notes, drawings and collections. Numerous methods and projects for arousing and maintaining a vital interest in the subject are briefly described and should be of real value to teachers of biology in the grades. There is an adequate index.

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Proceedings and Transactions of the Liverpool Biological Society, *Volume 48. Sessions 1933–1934; 1934–1935.*

Edited by R. J. Daniel, with the cooperation of S. T. Burfield and W. S. Laverock. University Press, Liverpool. 1 Guinea. $8\frac{3}{8}$ x $5\frac{1}{4}$; xii + 97; 1935.

The most interesting paper in this report is that on the "Growth of the Young Lobster," by W. C. Smith.

> The rearing experiments furnish evidence that moulting and mortality, in the case of young lobsters, are almost confined to the summer months, with temperatures over 10°C., and that the growth and death rates reach a maximum with temperature. They also indicate that June-hatched lobsters usually moult seven times in the first growth period, June–December, although some individuals may go through the process four, and others as many as eight times. Moulting occurs from two to five times in the second year, but principally three times; and the third year records show two or three moults, with one case of a single moult. There are four instances of fourth year lobsters, and they all moulted twice. One lobster moulted once, and another on two occasions, in the fifth year; and all later years up to eleven (for which there are records of one lobster) give one moult annually.

Tables of measurements at various periods are given.

A second article by the same author in collaboration with T. N. Cregeen tells of experiments to determine the optimum environment for rearing lobster larvae to the lobstering stage.

Колевания Численности Промысловых Животных.

А.Н.Формозов. Всесоюзное Кооперативное Об'единенное Издательство, Москва-Ленинград. 2 руб.; 108; 1935.

[Fluctuations in Numbers of Game Animals.
By A. N. Formosov. All-Union Cooperative Publishing House, Moscow-Leningrad. 2 roubles. 6 x $8\frac{1}{2}$ inches; 108; 1935 (paper)].

In these days of the work of *The International Conference on Biological Cycles and Bureau of Animal Population* a book summarizing the data on periodic fluctuations in numbers of economically important Russian game animals comes as a welcome contribution.

Dr. Formosov, who is well known by his original investigations on the subject, has divided his book into two unequal parts. The first part dealing with mammals (pp. 3–86) gives an account of hare, squirrel, polar fox and common fox populations; the second part (pp. 87–106) treats hazel grouse, ptarmigan and some other birds. In conclusion he notes that fluctuations in numbers are more sharply outlined in animals possessing high fertility, and that the whole subject is of very great economic importance.

* * *

Tissue Culture. *The Growth and Differentiation of Normal Tissues in Artificial Media.*
By E. N. Willmer. Methuen and Co., London. 4 shillings net. $6\frac{3}{4}$ x $4\frac{1}{4}$; xvi + 126 + 3 plates; 1935.

This little volume (of Methuen's Monographs on Biological Subjects) gives briefly but simply an account of the "part played by the method of tissue culture, . . . , in helping to elucidate some of the problems of normal growth and differentiation, and in furthering the knowledge of the processes involved in the normal development of the animal organism." Obviously it has been impossible to give a full account of all the ways in which the method of tissue culture has been applied. The author has not touched on the subject of the growth of malignant cells, of the sensitivity of these and normal cells to radium and x-rays, or of any of the applications of the method to problems of pathology. The volume is illustrated and well documented and contains an index.

* * *

Phénomènes d'Intégration dans les Cultures des Tissus. *Actualités Scientifiques et Industrielles 240. Exposés de Biologie (Embryologie et Histogenèse) IV.*
By Boris Ephrussi. Hermann et Cie, Paris. 8 francs. 10 x $6\frac{1}{2}$; 24; 1935 (paper).

A short resumé of the investigations of the author and others on the growth, limit of size and form of tissue cultures. Among the conclusions drawn are: (a) Tissue cultures possess a tendency toward definite size and form. (b) The equilibrium of a culture as regards its growth and spreading out depends upon the media and optimum density of population, nourishment and waste products. (c) Cellular division and mitosis take place at the periphery, and the cellular elements become a heterogeneous rather than a homogeneous whole as the older cells change. (d) Cells seem to grow faster when they come from a large area and mass, and this accounts for the fact that healing takes place more rapidly in an invagination.

* * *

Problems in Experimental Embryology *being the Thirty-sixth Robert Boyle Lecture. Delivered before the Oxford University Junior Scientific Club on May 26, 1934.*
By Julian S. Huxley. Oxford University Press, New York. 35 cents. $8\frac{1}{2}$ x $5\frac{1}{2}$; 17; 1935 (paper).

A popular exposition of some aspects of recent advances in experimental embryology. The address ends on the following note:

> Experimental embryology differs from classical physiology in being concerned, obviously and all the time, with change, orderly but progressive. No transformations so radical nor so irreversible as these of embryology occur in the adult vertebrate body. It will be in developmental physiology that the concept of rate of biological change will first require thorough-going analysis. It is probable that, once analysed there, it will extend in fruitful influence through other branches of biology.

Рост Животных.

Сборник работ под редакцией И.Шмальгаузена, Б.Токина, С.Капланского и М.Мицкевича. Государственное издательство биологической и медицинской литературы, Москва-Ленинград. 7 руб. 80 коп.; 368; 1935.

[Growth of Animals.
Collected papers edited by J. Schmalhausen, B. Tokin, S. Kaplansky and M. Mitzkewitsch. State Publishing House for Biological and Medical Literature, Moscow-Leningrad. 7.80 roubles. 6 x 9 inches; 368; 1935 (cloth)].

This book is written by Russian biologists who, during the last ten years, have contributed to the study of different aspects of the growth problem. Professor Schmalhausen has three papers: (1) Basic conceptions and methods of study of growth, (2) Growth and body size in their biological meaning, (3) Growth and differentiation. Doctor E. M. Wermel in a very thorough and readable review, "Size, multiplication and growth of cells," summarizes the results of his recent investigations on the subject. There are papers by Nasarenko and Spett, "On the hereditary factors of growth," and by Professor W. W. Alpatov on "Environment and animal growth."

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Handbuch der biologischen Arbeitsmethoden. *Lieferung 444. Abt. V. Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus, Teil 10, Heft 5. Allgemeine und vergleichende Physiologie.* Containing following articles: *Einige Verfahren zur mikroskopischen Bestimmung der Brechzahlen von Zellen und Geweben*, by W. J. Schmidt; *Die Mikrostrahlstichmethode und andere Methoden des zytologischen Mikroexperimentes*, and *Transport von Sexualprodukten von Seeigeln in überlebendem Zustand für experimentelle Zwecke*, by Sergei Tschachotin; *Die Technik photographischer Aufnahmen bei mikroskopischen und fluoreszenz-mikroskopischen Lebendbeobachtungen*, by Kurt Franke; *Die wichtigsten mathematischen Methoden bei der Bearbeitung von Versuchsergebnissen und Beobachtungen*, by Heinrich Reichel.
Urban und Schwarzenberg, Berlin. 14 marks. 10 x 7; 248; 1935 (paper).

Article I deals with several experiments on microscopical determination of refractive indices of cells and tissues. Article II concerns various microscopic rays to be used in cytological work. Article III deals with methods of transporting the sexual products of sea urchins in a living condition. Article IV is concerned chiefly with photographic technique of living material with the ordinary microscope and the fluorescent microscope. Article V is a discussion of biometric constants and formulas.

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Les Associations Biologiques au Point de Vue Mathématique. *Actualités Scientifiques et Industrielles, 243. Exposés de Biométrie et de Statistique Biologique, V.*
By Vito Volterra and Umberto d'Ancona. Hermann et Cie, Paris. 20 francs. 10 x $6\frac{1}{2}$; 96; 1935 (paper).

In this book the authors develop mathematical equations which describe the interaction of animal and plant populations in various fundamental relationships. The following relations are considered: the variation in numbers of a single species living isolated in its environment; the relations of two species living together, and certain types of associations between many species. These three types of relationships are extended to a number of special cases such as predator and prey interactions, parasite and host interactions, competition between different species for food, etc. After formulating equations to describe these associations the authors conclude, by discussing the experimental work of themselves and others, that actual observations confirm many of the predictions made on mathematical grounds.

This monograph should be in the library of all students of quantitative biology. It is a scholarly contribution to this field.

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An Introduction to Biology.
By Edward L. Rice. Ginn and Co., Boston. $3.20. $8\frac{1}{4}$ x $5\frac{1}{2}$; xii + 602; 1935.

This volume is the outgrowth of the author's twenty-five years experience in teaching elementary biology in Ohio Wesleyan University. It is a sampling of the subject rather than a survey. After three introductory chapters in which are discussed: What is Biology?; Protoplasm, cells, tissues, organs, systems; and Osmosis, eight chapters are devoted to man and eight to the frog. Then follows a section on the classification of animals and five sections on the lower animals and plants. The last six sections are devoted to evolution, heredity and variation. In a series of appendices are given (a) Table of equivalents, (b) bibliography and (c) etymologies. The volume is well illustrated and indexed. An excellent text.

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THE WORLD OF NATURE.

By H. C. Knapp-Fisher. Victor Gollancz, London. 6 shillings net. $7\frac{1}{4} \times 4\frac{7}{8}$; 512; 1935.

This simply written little book makes the attempt to give some sort of indication of the characteristics of all the different sorts of living things in the world of nature. It is divided into four parts: The Sea Shore; An Outline of the Plant World; A Simple Survey of Insect Life; and Fish, Flesh and Fowl. Each chapter is so attractively introduced and the actual descriptions so delightfully and ingeniously written that it should fascinate the most unscientific of minds, young and old.

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LOGIK UND SYSTEM DER LEBENSWISSENSCHAFTEN.

By Fritz M. Lehmann. Johann Ambrosius Barth, Leipzig. 7.30 marks. $9\frac{1}{4} \times 6\frac{1}{4}$; vii + 124; 1935 (paper).

A practicing physician believes that the scientific world needs a new theory of life processes, and herein gives a recipe. This new dish—a hashed assortment of transcendental dialectics, Faustian empirical philosophy, and the biology of healing processes and other aspects of medical and physical sciences—is labeled metabiology. The author lists and discusses the ingredients but leaves the final mixing and cooking to other persons, presumably to be inspired by this book.

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URDEUTSCHLAND. *Deutschlands Naturschutzgebiete in Wort und Bild. Lieferungen 11, 12.*

By Walther Schoenichen. J. Neumann, Neudamm. 2 marks each, or 24 marks for complete set; 28 marks bound volume. A cover for the complete volume may be purchased from the publisher for 2.50 marks. $10\frac{3}{4} \times 8\frac{1}{4}$; Lief. 11, 241–272 + 8 plates; Lief. 12, 273–319 + xi + 9 plates; 1935 (paper).

These two numbers complete the first volume of an illustrated discussion of the geological formation, and the flora and fauna of Germany. Previous numbers have already been noticed in these columns (Vol. 10, numbers 3 and 4). Volume 1 is devoted to the geology.

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STUDENT'S MANUAL IN BIOLOGY.

By Frederick L. Fitzpatrick and Ralph E. Horton. Houghton Mifflin Co., Boston. 48 cents. 11 x 8; iv + 155; 1935 (paper).

This manual is designed as a student notebook, or guide in studying demonstrations in the laboratory. It is designed especially to be used with a textbook by the same authors, but could be profitably used with any good text.

HUMAN BIOLOGY

A DOCUMENTARY HISTORY OF PRIMITIVISM AND RELATED IDEAS. *Volume I. Primitivism and Related Ideas in Antiquity.*

By Arthur O. Lovejoy and George Boas, with Supplementary Essays by W. F. Albright and P.-E. Dumont. The Johns Hopkins Press, Baltimore. $5.00. $9\frac{5}{8} \times 6\frac{1}{4}$; xv + 482; 1935.

This is the first volume in an ambitious and important scholarly undertaking. Its object is to set forth in detail and support with extensive quotations from the original sources an idea, or better a group of ideas, that mankind has been prone to entertain from time to time since the beginning of his recorded history—namely the notion that the life of primeval men, or of men of some remotely earlier time, or of "savage" peoples, was a better life than that of civilized men. It is evident that this is a matter of great interest to all students of human biology. To them this volume and its successors as they appear will be a useful and valued reference source book, as well as to students of literature, history and philosophy to whom the work is more particularly addressed. This first volume deals with the thought of ancient Greece and Rome on the point, with brief supplementary essays on primitivism in ancient western Asia (Mesopotamia and Israel) and in ancient India.

The theme and counter-theme that run through the whole history of primitivism are:

1. "There were giants in them days."
2. "Frail men from grace did fall."

Precisely when, where and why the giants or the falling occurred is never specified in too great detail. But the general idea that they did is in Homer and Hesiod, just as it is in the latest bulletin of the last organization set up to save the nation.

The reputation of the authors is a sufficient guarantee of the soundness and thoroughness of the work. All quotations are first given in the original language, and followed by an English translation, the latter being done evidently with an eye rather more to precision than grace. We do not mean to imply that the translations are generally awkward in their literalness. Quite the contrary is the fact. But, as an example, while it is true that δάκτυλον ἐκτείνειν (p. 127) means precisely "to stretch out a finger" Eusebius's context leaves no doubt that the more idiomatic English rendering "lift a finger" would have done no damage to his thought.

We strongly recommend this book to our readers. In a quite literal sense no library worthy of the name will be without it.

MAN THE UNKNOWN.

By Alexis Carrel. Harper and Bros., New York. $3.50. 8½ x 5¾; xv + 346; 1935.

This book was classified in a recent booklist under the head of Fiction. This was, no doubt, unintentional; yet one comes with a shock on such a passage as the following in the work of an austere experimentalist like Carrel.

> Our present conception of the influence of prayer upon pathological lesions is based upon the observation of patients who have been cured almost instantaneously of various affections, such as peritoneal tuberculosis, cold abscesses, osteitis, suppurating wounds, lupus, cancer, etc. The process of healing changes little from one individual to another. Often, an acute pain. Then a sudden sensation of being cured. In a few seconds, a few minutes, at the most a few hours, wounds are cicatrized, pathological symptoms disappear, appetite returns. Sometimes functional disorders vanish before the anatomical lesions are repaired. The skeletal deformations of Pott's disease, the cancerous glands, may still persist two or three days after the healing of the main lesions. The miracle is chiefly characterized by an extreme acceleration of the processes of organic repair. There is no doubt that the rate of cicatrization of the anatomical defects is much greater than the normal one. The only condition indispensable to the occurrence of the phenomenon is prayer. But there is no need for the patient himself to pray, or even to have any religious faith. It is sufficient that some one around him be in a state of prayer. Such facts are of profound significance. They show the reality of certain relations, of still unknown nature, between psychological and organic processes. They prove the objective importance of the spiritual activities, which hygienists, physicians, educators, and sociologists have almost always neglected to study. They open to man a new world.

We wish that the author had had space to present the records on which these statements are based. We are prepared to admit that there may be more things in the relation of mental to physiological processes than are dreamt of in the current orthodoxy of science but the correction of the skeletal deformations of Pott's disease in a few days taxes our belief.

As a whole the book develops a program for the synthesis of physiology, psychology and the social sciences into a science of man. Carrel is no admirer of present-day civilization in many of its aspects. The lagging of our knowledge of man behind that of the external world, the too sheltered environment and the consequent disuse of the adaptive functions, are fraught with danger. Yet there is a beacon of hope in the darkness. "Medicine aggrandized according to the conception of Descartes, and extended in such a manner as to embrace the other sciences of man, could supply modern society with engineers understanding the mechanisms of the body and the soul of the individual, and of his relations with the cosmic and social world."

The proposal is an arresting one. These superphysicians, these social engineers, might not solve all the problems of humanity; yet we have a suspicion that they might well do a better job than the present masters of mankind.

LE DESTIN DES RACES BLANCHES.

By Henri Decugis. Librairie de France, Paris. 38 francs. 10 x $6\frac{1}{2}$; vii + 402; 1935 (paper).

In common with most people, the author is appalled by the present economic conditions, but unlike many economists he is unable to perceive any benefits to be derived from governmental interference in business. The author's method of analysis of economic trends is simple and straightforward. He presents a summary of statistical information regarding the changes in production cost and distribution of the more important commodities, the developments in transportation, international finances, etc. He also discusses population questions and political forms of government. He believes that in the United States the liberal form of government is rapidly coming to an end. The conclusions reached are not novel, but in the form stated by the author appear excessively pessimistic. They may be summarized as follows: (1) Europe has lost its economic and financial hegemony, its tariff barriers serve only to prolong the agony of a dying agriculture and industry; (2) the industry of the United States is geared to a production higher than its marketing possibilities which government aid to farmers cannot possibly augment; (3) Japan has successfully invaded the world's market with its products and in China has not only a large unexploited market but also a rich source of raw materials. The author does not attempt to find a remedy for these conditions but emphasizes that a continuation of the post-war government policies will only make matters worse. It is evident that this book presents nothing new, but it is superior to some similar recent studies because (a) it is factual (in minor instances the sources of data do not appear reliable) and, (b) there is an attempt, very feeble indeed but still an attempt, to view our present civilization as only one phase in the general evolution of man. The increasing number of unemployed, the excessive government interference in commerce, the decrease in birth-rates, etc., were observed and associated with the decline of ancient Greece and Rome. The author fears that at present they are symptoms of the decline of European civilization.

THE MEDICAL MAN AND THE WITCH DURING THE RENAISSANCE. *The Hideyo Noguchi Lectures*.

By Gregory Zilboorg. The Johns Hopkins Press, Baltimore. $2.50. $7\frac{3}{4}$ x $5\frac{1}{2}$; x + 215 + 4 plates; 1935.

Probably the earliest view of disease, both mental and physical, was that it is the result of possession by an evil spirit or of the maleficent spells of a sorcerer. Although the Greek physicians from Hippocrates to Galen regarded both types of disease from a naturalistic viewpoint, their successors washed their hands of psychiatry, leaving the problem to the theologians and lawyers, who, as usual, made an inhuman mess of it. The real founder of modern psychiatry was Johann Weyer, whose *De Praestigiis Daemonum* was published at Basel in 1563. In this he ridiculed the tales of witches riding through the air to their sabbaths and insisted that the proper person to treat mental ills was not the exorcist but the physician. He attributed many of the supposed effects of sorcery to poisons and the delusions of those accused of witchcraft to such drugs as belladonna and opium.

It was not until a later age that Weyer's attitude towards psychopathology was generally adopted. The reaction of his contemporaries is typified by the contemptuous dismissal of his arguments in the Saxon criminal code of 1572 "since he was a medical man and not a jurist." His own church placed his writings on the *Index Librorum Prohibitorum* where they remain to this day. Does this mean that a Roman Catholic psychiatrist is bound by his faith to turn over his patients to the ecclesiastical courts for trial as witches?

CIVILISATION AND THE GROWTH OF LAW.

A Study of the Relations Between Men's Ideas About the Universe and the Institutions of Law and Government.

By William A. Robson. The Macmillan Co., New York. \$2.50. $8\frac{1}{2}$ x $5\frac{7}{8}$; xv + 354; 1935.

The author outlines the gradual evolution of law, and notes the progress from the primitive assumption that directly or indirectly it was derived from supernatural powers to the modern concept that it is a product of society. He shows how at different periods law has been influenced by superstition, religion, philosophy and science. Science itself has passed through a similar evolution. He observes that until recently "the wheels of the universe were supposed to revolve in a purely objective and mechanical way and it was felt to be a grave impropriety to suggest that the laws which described their movements had any relation to human life or thought" (p. 328). But now, . . . "it is the human mind which both formulates the pattern of physical conduct we call natural law and also establishes the pattern of social conduct we call human law" (p. 328). So, he concludes that since man now realizes that he is free to create whatever type of society he desires (and also whatever solar system he wishes, one can presume) probably he will do so and much misery and unnecessary suffering will eventually pass away.

We admire the brilliant style in which the book is written and the erudition of the author; and enjoy the formal logic employed in the discussion but regard such a conclusion as something of an anticlimax. Since time immemorial, no matter what their superstitions or religious beliefs, men have tried to find some way to overcome social misery and suffering, but unfortunately, they have never agreed, either on the method or on a satisfactory definition of the objective.

THE INDIAN PEASANT AND HIS ENVIRONMENT.

(The Linlithgow Commission and After).

By N. Gangulee. Oxford University Press, New York. \$4.00. $8\frac{3}{4}$ x $5\frac{1}{2}$; xxiii + 220 + 8 plates; 1935.

By means of selected letters written to various persons during the many years he has been studying Indian agriculture and rural problems, and extracts from his journal kept during 1926–28 while serving as a member of the Royal Commission on Indian Agriculture (of which Lord Linlithgow was chairman) Prof. Gangulee pictures the agricultural problems and agrarian discontent as they exist in India. The letters and extracts are classified into five chapters. The first, "Glimpses into Indian Villages," sets forth the fundamental handicaps under which the Indian peasant (ryot) labors: Illiteracy, disease, complicated land tenure systems, pernicious money lending schemes, absence of suitable subsidiary occupations, lack of irrigation facilities, inadequacy of agricultural machinery and methods, etc. Chapter II, "Economic Life in Rural India," shows the necessity of reconstructing the entire organization of the cultivator, the necessity of a thorough overhauling of Indian land tenure systems to bring them into conformity with the needs of modern agriculture, coöperative movements to extricate the peasant from the clutches of the money lenders, and to provide him with adequate resources to enable him to avail himself of improved techniques for raising and marketing agricultural products.

In Chapter III, "Social Life, Education and Health in Rural India," Dr. Gangulee pleads for education of the masses to stamp out illiteracy, "the root cause of all our troubles"; malaria, "our most indigenous enemy" and malnutrition, "perhaps our chief disability"; and paves the way for a program of "Rural Reconstruction in India" (Chapter IV), the first objective of which must be "directed to the means by which he [the peasant or cultivator] may be made conscious of his legitimate rights so that he himself may know what to demand and how to demand it." The last chapter, "The Government of the Masses," is made up of several letters on the constitutional problems of rural India, recommending that the constitution makers become better acquainted with the conditions of the peasantry and the constitution under the reforms be raised on the foundation of local self-government.

The book is well illustrated with photographs; there is a glossary of Indian words, and an index. An interesting and valuable contribution.

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Primitives and the Supernatural.
By Lucien Lévy-Bruhl. Authorized Translation by Lilian A. Clare. E. P. Dutton and Co., New York. $5.00. 8½ x 5¾; 405; 1935.

In this interesting book the author treats in more detail than in his previous works certain aspects of the attitude of primitive peoples towards the supernatural influences which to their way of thinking are the real masters of their destiny. Surrounded by a hostile and incalculable environment, to which their predominant reaction is fear, they see no hope of safety except in "a pious adherence to the protective traditions handed down by former generations. In spite of the dangers menacing them on all hands their ancestors were able to live and to transmit life. With that life their descendants received from them a code of precepts and prohibitions, the faithful observance of which will enable them to survive like their fathers, and to secure the perpetuity of the group."

Among the subjects treated are good and bad luck, the favorable or unfavorable "dispositions" of the unseen powers, the ritual ceremonies and dances by which they are propitiated, the worship of ancestors and of the dead, witchcraft, incest, defilement and purification, the magic virtues and sinister powers of blood, and methods of purification.

Our own feeling towards this, as towards Lévy-Bruhl's other works, is that he is inclined to overemphasize the gap between the mind of primitive and of modern man, to neglect the survivals of pre-logical mentality among more highly developed cultures. For instance, he mentions the belief in bi-presence as characteristic of primitive modes of thought; yet to the men of the Middle Ages the bi-presence of St. Anthony of Padua was matter of common belief.

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Essays of William Graham Sumner. *In two volumes.*
Edited, with Prefaces, by Albert G. Keller and Maurice R. Davie. Yale University Press, New Haven. $3.00 per volume. 8¾ x 6; Vol. 1, xix + 409; Vol. 2, viii + 534; 1934.

Professors Keller and Davie and the Yale University Press have done the world a signal service in producing this definitive edition of Sumner's essays. William Graham Sumner was not only by a long way the greatest sociologist America has produced; the science itself has had but very few men in its history of Sumner's intellectual caliber. He was that rare sort of person who could be a thorough scholar and not at the same time be a pedant. Nearly everything he ever wrote could be read with both pleasure and understanding by any intelligent man. Furthermore much of it was published in places easily accessible to the non-academic public. It is reasonable to suppose that these attributes of his work were not accidents. Instead he saw, as Huxley did, that scholarly effort that deliberately confines itself to the narrow circle of professional colleagues not only is practising self-mutilation, but is making more difficult the whole task of the advancement of learning. For if science is to live it can only be through the good will and support of the public in the long run.

Seldom has Sumner's moral courage been matched in the history of mankind.

He blasted quackery wherever he saw it, regardless of potential consequences, personal or institutional. The longest essay of the lot exposes, and then annihilates with a consuming fire of logic and ridicule that Sacred Cow of 100-percent Americanism, the theory of protective tariffs.

We predict that these beautifully produced and soundly edited volumes will have a large and steady sale. They embody a contribution to human thought of permanently enduring value.

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MIGRATION AND PLANES OF LIVING, *1920–1934*.

By Carter Goodrich, Bushrod W. Allin and Marion Hayes. University of Pennsylvania Press, Philadelphia. $1.00. 10 x $6\frac{3}{4}$; viii + 111 + 2 folding maps; 1935 (paper).

This survey has for its purpose to build up a part of the factual basis on which an intelligent migration policy might be predicated. The first survey by C. Warren Thornthwaite published in 1934 was concerned with an analysis and mapping of past currents of internal migration, beginning at the earliest time at which they could be studied in the state-of-birth figures of the Census and continuing in greater detail with the somewhat more abundant data of recent decades.

The present bulletin presents estimates of population changes over a considerable portion of the country for the years since 1930 and discusses the question of whether "those who moved gained or lost, and to what extent have their migrations performed the function, so eloquently described in the simpler textbooks of economics, of moving labor from points of redundancy to points of need?" Throughout the text will be found the data arranged in tables and graphs and charted on maps. Appendix A explains the mapping of special types of areas, Appendix B gives the tabular analysis of special types of areas grouped according to percentage of population on relief, and Appendix C discusses the reliability of school census data.

WHITE MAN'S COUNTRY. *Lord Delamere and the Making of Kenya. Volume I, 1870–1914; Volume II, 1914–1931.*

By Elspeth Huxley. The Macmillan Co., New York. $10.00 for the two volumes. $8\frac{3}{4}$ x $5\frac{3}{4}$; Vol. I, xiii + 315 + 12 plates and 2 folding maps; Vol. II, vii + 333 + 12 plates and 2 folding maps; 1935.

This thorough and scholarly treatise is essentially a biography of Hugh Cholmondeley, third Baron Delamere, set in the background of the history of Kenya Colony. Delamere believed that Kenya was a "white man's country" from the day he first hunted over it as a young man. He devoted his life and his fortune to proving his point and making other people believe it too. England ran the country from the Colonial Office in London in the best British tradition of stupid muddle-headedness. Delamere derived great pleasure and satisfaction from periodically telling the Pooh-Bahs back home and in Nairobi precisely what he thought of them. On the evidence his command of picturesque profanity must have been nearly or quite unparalleled in recent times. He further enjoyed the enormous advantage of being able, when things got too thick, to go home and take his proper seat in the House of Lords and from that vantage point tell Government where to alight. Altogether he was a wicked fellow, but a grand man. He devoted his life unselfishly and unstintingly to making a fine and high ideal a reality.

The book is a superb piece of historical research and writing. It will long stand as a reference work of first importance to students of colonization, ethnology, and sociology generally.

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NASKAPI. *The Savage Hunters of the Labrador Peninsula.*

By Frank G. Speck. University of Oklahoma Press, Norman. $3.50. 9 x 6; 248 + 20 plates; 1935.

Professor Speck sets forth in this book the first study of the religious life of the Montagnais-Naskapi, seminomadic bands living in perhaps the most physically exacting and rigorous climatic environment of any peoples of the earth. Essentially a race of hunters, obtaining subsistence solely by the chase, these crude and simple people "have worked out a spiritualistic system as complete and as artificial for gaining control over animal spirits as their hunting devices and weapons are effective in accomplishing the physical slaughter of game" and remain impervious to any teaching which does not satisfy their emotional needs. Hunting is to them a holy occupation and since through animal life health and happiness come to the Naskapi, animals become the primary objects of religious zeal. This is manifest in their art, their dancing, and their games.

Special chapters are devoted to spiritual forces, concept of the soul, concepts of mythology and the universe, animals in special relation to man, divination, magic practices, medicinal practices and charms for hunting. A glossary of Indian words, an explanation of characters employed in recording native terms and an index complete this interesting and thought-provoking book.

This study is the tenth volume in the "Civilization of the American Indian Series," published by the University of Oklahoma Press.

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THE TARAHUMARA. *An Indian Tribe of Northern Mexico.*

By Wendell C. Bennett and Robert M. Zingg. University of Chicago Press, Chicago. \$4.00. $8\frac{1}{8}$ x $5\frac{3}{8}$; xix + 412 + folding table; 1935.

This ethnological study is concerned with one of the largest tribes of American Indians north of Mexico City. The authors took up their abode with these Indians and studied all aspects of their culture. They have produced an authentic and highly interesting book. Living in the isolated mountain regions of the Sierra Madre in the summer and migrating in the colder months to the warmer caves of the rivers, the Tarahumara have maintained to a marked degree their simple aboriginal culture. The thin veneer of Spanish culture is recognizable with considerable certainty. Violins and guitars are manufactured with a fair amount of skill. The native fiestas are of ancient origin and involve only the Tarahumara daily life. The church fiestas, introduced by a priest 40 or 50 years ago, have been absorbed but greatly modified and extended by native imagination until today they form one of the most important parts of the social culture of the Indians.

The volume contains a number of plates and diagrams, a bibliography and an index. Of particular value to the student is the excellent tabular analysis of the culture of Sonoran Uto-Aztekan tribes.

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ANTHROPOLOGY IN ACTION. *An Experiment in the Iringa District of the Iringa Province, Tanganyika Territory.*

By G. Gordon Brown and A. McD. Bruce Hutt. Oxford University Press, New York. \$2.75. $7\frac{1}{4}$ x $4\frac{3}{4}$; xviii + 272 + folding map; 1935.

This book is the outcome of an interesting experiment made possible by a grant from the Rockefeller Foundation. Its object was to determine whether, and in precisely what ways, a thorough anthropological study of a native group by a trained specialist, would be practically useful in the administration of the group. The group on which the experiment was tried was the Hehe tribe living in the Iringa district of Tanganyika Territory. Brown was the anthropologist and Hutt the administrator. Both were experienced in the district before the specific undertaking started. The general result as set forth in the book is a sound, well reasoned, and judicious, if not particularly exciting contribution. One gets the impression that the Hehes will, on the whole, profit more from the writing of the book than anyone else, though few if any of them will probably ever read it. They are passing through a difficult cultural transition phase, and will undoubtedly be better administered as time goes on because this work has been done. The book has an adequate index.

TESTS AND MEASUREMENTS IN THE SOCIAL SCIENCES. *Report of the Commission on the Social Studies, Part IV.*
By Truman L. Kelley and A. C. Krey. Charles Scribner's Sons, New York. $3.00. $7\frac{3}{4}$ x $5\frac{1}{8}$; xiv + 635; 1934.

The Commission on the Social Studies in the Schools started its work with high hopes of the applicability of new-type tests to the teaching of the social sciences. However, as the work progressed the social scientists on the Commission seem in general to have concluded that, while the new-type test is well adapted to measuring knowledge of specific events and of the simpler relationships of this material, "the more advanced and complex stages of these values . . . must as yet be discovered by other forms of test." The tests developed in the work of the Commission and described in this book relate to the understanding of the vocabulary of the social sciences, the ability to read maps, to draw other geographical inferences and to use historical evidence, and to the diagnosis of traits of character. There is a bibliography of 24 pages but no index.

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LA COSTITUZIONE NELLE ARISTOCRAZIE ITALIANE. *Pubblicazioni della Università Cattolica del Sacro Cuore. Statistica, Vol. VIII.*
By Carlo Mengarelli. Università Cattolica del Sacro Cuore, Milano. L. 15. 10 x $6\frac{1}{2}$; viii + 165; 1935 (paper).

The author has compared the mean stature and weight of three samples of Italian men. These are: (a) university teachers and artists, (b) leading business men, members of parliament and high state functionaries, (c) life insurance policy holders. Keeping the average age and "racial" composition of the groups constant, it is found the men of category (b) are the tallest and the policy holders are the shortest. With stature also made constant, the group of university teachers and artists is inferior in weight to the other two groups.

This study is characterized by the painstaking efforts of the author to ascertain that the three groups were really comparable to each other for the purpose of this investigation. There is an interesting discussion on the problem of the somatic constitution of the "élites," but it seems doubtful this type of study can contribute much towards a solution of this question.

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INDIANER-RASSEN UND VERGANGENE KULTUREN. *Betrachtungen zur Volksentwicklung auf einer Forschungsreise durch Süd- und Mittelamerika.*
By Richard N. Wegner. Ferdinand Enke, Stuttgart. 15 marks (paper); 17.50 marks (cloth). $10\frac{3}{4}$ x $7\frac{1}{4}$; viii + 320 + 128 plates; 1934.

With the exception of the final chapter which treats of the Mayas of Yucatan, this book describes the culture, habits, games, appearance, and surroundings of some South American Indian tribes (almost exclusively those inhabiting the Chaco districts of Paraguay and Bolivia, and Peru) visited by the author in his travels during 1927–29. Historical matter is included concerning former cultures, migration, numbers, inter-racial and inter-tribal marriages, etc., as gleaned from records of early explorers. There is little new information concerning the Incas and Mayas. However, the study of the lesser known Chaco tribes is a contribution of value to ethnologists and geographers.

The book is adorned with 128 very fine photographic plates, including some excellent portraits, and distinctive pen and ink drawings serving as head- and tail-pieces for the 14 chapters. It is documented.

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CULTURE AREAS OF NIGERIA. *Frederick H. Rawson-Field Museum Ethnological Expedition to West Africa, 1929–30. Field Museum of Natural History Publication 346.*
By Wilfrid D. Hambly. Field Museum of Natural History, Chicago. $2.00. $9\frac{1}{2}$ x $6\frac{1}{4}$; 140 + 68 plates; 1935 (paper).

The first part of this report describes the types of industries found in Nigeria and the characteristics of their products.

North of 9° N. L. the culture is preponderantly of the Mohammedan type and shows clearly the effect of diffusion, by immigration and other contacts, from the north of Africa across the Sahara. This type of culture evidently replaced the indigenous, typically Negro, which is more and more prevalent as one proceeds south from the 9° parallel to the region of the dense tropical forests. The author indicates in convincing manner the interrelationship between geographical condition, history of migrations and the blending and differentiation of cultural patterns. The second part of this monograph includes brief comments on the customs of the several peoples inhabiting Nigeria. The clear verbal descriptions are rendered more interesting by numerous illustrations and photographs.

AGRICULTURE IN SOUTHERN AFRICA. *United States Department of Agriculture Technical Bulletin No. 466.*

By Clifford C. Taylor. U. S. Government Printing Office, Washington, D. C. 30 cents. $9\frac{1}{8} \times 5\frac{3}{4}$; 342; 1935 (paper).

This bulletin presents a survey of the conditions and trends of agriculture in South Africa. The author analyses the quantity and quality of production, and the methods of marketing and exportation of the more important commodities such as wool, mohair, fruits, tobacco, cotton, sugar, cattle, and corn. From this analysis it appears that the production of wool, mohair and exportable corn is decreasing while that of cattle, citrous fruit, deciduous fruit and sugar is increasing. It is evident that a similar trend will eventually affect international trade and especially American exporters.

The facts here contained have been well assembled and brought to date. They also include data on the populations and on the physical characteristics of the different regions.

IS INDUSTRY DECENTRALIZING? *A Statistical Analysis of Locational Changes in Manufacturing Employment 1899–1933.*

By Daniel B. Creamer. University of Pennsylvania Press, Philadelphia. $1.00. $10 \times 6\frac{5}{8}$; xii + 105; 1935 (paper).

The author presents statistics of the number of wage earners employed in all manufactures from 1899 to 1933 and in 24 industries from 1928 to 1933, distributed according to geographical regions and according to defined categories of industrial areas. He notes that in the principal cities the number of wage earners has decreased but that a decentralization of the major industrial centers has not been apparent until 1932–1933. The only real sign of decentralization is found in the South Atlantic states (not of great industrial importance) and for certain branches of the textile and of the boot and shoe industries. The author has apparently extracted all the possible information from the meagre data available and discusses the results in an objective manner.

OUTLOOK UPON THE FUTURE OF BRITISH UNEMPLOYED, MENTAL PATIENTS, AND OTHERS.

By Nathan Israeli. Science Press Printing Co., Lancaster, Pa. 50 cents. 10 x 7; 30; 1935 (paper).

By means of multiple choice questionnaires the author has sought to measure and compare "the outlook upon the future" of selected groups of British unemployed, mental patients, university students and superior high school students. The results seem to indicate that in certain particulars the unemployed are even less hopeful about their future than patients with anxiety neurosis. On the other hand the superior high school students are strikingly similar to the manics in manifesting a high degree of optimism. Although these results conform to expectations, there always remains the doubt if these tests, as well as others of the same type, actually achieve the intended objectives.

GOOD FOOD FROM SWEDEN. *Selections from Swedish Dishes Suited to an English Table.*

Compiled by Inga Norberg. Chatto and Windus, London. 5 shillings net. $7\frac{1}{4}$ x 5; vii + 176; 1935.

The Swedes are husky eaters and drinkers, as any wanderer into the *Hinterland* of their charming country soon learns. Furthermore they have a long tradition of good cooking, about which the casual tourist who lives on the internationalised quasi-French cuisine of the first-class hotels in big cities knows nothing. This little volume does a real service in letting the world know that all Swedish food is not "outside works," as the conscientious doughboy in his innocence translated *hors d'oeuvres*. In reading it over, however, one is struck again by the fact that the national taste, as is proper in so northern a clime, runs strongly to food that will "stick to the ribs"—good solid stuff with a high calory yield per unit consumed.

THE TRESSÉ IRON-AGE MEGALITHIC MONUMENT. *Its Sculptured Breasts and Their Relation to the Mother-Goddesc Cosmic Cult.*

By V. C. C. Collum. Oxford University Press, New York. $4.00. 10 x $7\frac{1}{2}$; xiv + 170 + 35 plates; 1935.

By a careful technique of excavation the author was enabled to prove that the Gallo-Roman pottery and iron sword which were found were not due to later disturbance and that therefore this megalithic tomb had been erected during the Roman occupation of Gaul. The four human breasts sculptured in relief are related by the author to the cult of the Great Mother, so popular in Armorican Gaul during the Roman occupation. She traces the cult in Egypt, Mesopotamia, India and Greece as well as its survivals in early Irish mythology. There is a bibliography of eight pages.

HASHISH.

By Henry de Monfreid. Translated by Helen B. Bell. Methuen and Co., London. 10s. 6d. net. $8\frac{1}{2}$ x $5\frac{1}{2}$; vii + 284 + 9 plates; 1935.

"Hashish" tells of the author's adventures in smuggling this drug into Egypt. He buys it in Greece, ships it to Djibouti and then brings it up the Red Sea in a small boat. His adventures are vividly told and his enemies and accomplices well-drawn, but his frequent references to his earlier books are likely to be annoying and confusing to those who have not read them. For the discerning student of human biology there are many bits of useful material scattered through the book.

FOLK-LORE FROM ADAMS COUNTY, ILLINOIS.

By Harry M. Hyatt. Alma Egan Hyatt Foundation, New York. $6.00. $9\frac{5}{8}$ x $6\frac{1}{8}$; xvi + 723; 1935.

An excellently indexed collection of superstitions and folk lore, including rhymes and riddles, gathered from the inhabitants of Adams County, Illinois. These are numbered and grouped under one hundred and sixty-five chapter headings dealing with nearly every conceivable familiar subject. In addition to an index by chapters, each of the 10,949 subjects in this book is alphabetically indexed.

THE GROWTH AND DISTRIBUTION OF POPULATION.

By S. Vere Pearson. George Allen and Unwin, London. 12s. 6d. net. $9\frac{1}{4}$ x 6; 448 + 1 plate; 1935.

In spite of its title this prolix book is essentially Single Tax propaganda. Whatever the merits of the Single Tax we doubt whether it would prove to be such a panacea for population problems as Dr. Pearson thinks.

THE KATKARIS. *A Sociological Study of an Aboriginal Tribe of the Bombay Presidency.*

By A. N. Weling. Bombay Book Depot, Girgaon, Bombay. $8\frac{1}{8}$ x $5\frac{1}{4}$; iv + 156 + 15 plates; 1934.

An interesting study of the Katkaris, an aboriginal tribe of the Bombay Presidency. This book, with photographic illustrations, gives a complete description of the country and the people; their physical affinities, their homes, their arts and sciences and their beliefs and rituals.

ZOOLOGY

THE ARACHNIDA.

By Theodore H. Savory. Longmans, Green and Co., New York. $8.50. $9\frac{5}{8}$ x $7\frac{1}{4}$; xi + 218; 1935.

This is a well planned and well executed book on that somewhat neglected class of the Phylum Arthropoda, the Arachnida. The book is divided into three sections and an appendix. Part 1 discusses the general characteristics of the class as a whole; Part 2 describes the various orders, including fossil forms; and Part 3 is a review of different phases of the science of arachnology, which includes short chapters on economic, practical and historical arachnology. At the beginning of each chapter of Part 2 there is a diagnosis of about 100 words on the essential features of the order to be described, thus providing the means for a rapid survey of the characteristics of the whole class. The text is extremely well illustrated with outline drawings of at least one representative of each order, often supplemented with other line drawings of specialized structures, and in some cases still further supplemented with plates. Outline maps of the world show the distribution of the various orders of Arachnida. There are frequent tables of data that give a clean-cut air to the book. Mention should also be made of the author's "excursus" at the end of each chapter. This is usually about two pages in length and is generally an interesting little discourse on some particular feature of the class, such as "On Arachnid venom," "The spinning of Arachnida," "The tail and telson in Arachnida," "The Arachnida as formidable animals." The layman will find much of interest in this introduction to a fascinating group of creatures. For the zoölogist or naturalist it will also be a useful reference work.

In the appendix are extensive bibliographies, an *index rerum*, an *index auctorum* and an *index animalium*.

THE LONDON CONVENTION FOR THE PROTECTION OF AFRICAN FAUNA AND FLORA. *With Map and Notes on Existing African Parks and Reserves. Special Publication of the American Committee for International Wild Life Protection Number 6.*

American Committee for International Wild Life Protection, Cambridge. Free. $12\frac{1}{4}$ x $9\frac{1}{8}$; 48 + folding map; 1935 (paper).

The London Conference of 1933, called by invitation of the Government of Great Britain, was really a revival of the London Convention of 1900 which was never ratified. Representatives came to London from all of the countries having territories in Africa and there were "observers" from the Netherlands, India and the United States. The purpose of the convention was to institute a special regime for the preservation of rare or vanishing species of fauna and flora, particularly in Africa where they are in danger of extinction or permanent injury.

The text of the Convention as signed November 1933 is printed in full. The more important accomplishments are the defining and recommending of four types of parks and reserves and agreement aiming to control the commercial exploitation of animal products. An "Annex" contains illustrations and explanatory notes showing graphically the various mammals and birds recommended for special protection, and a 16-page table of African Game Reserves and National Parks, showing status and size of the various areas and the kind of game to be found in each. A large folding map shows the status of nature reserves in June 1935.

The terms of the treaty have been acceded to by Great Britain, Belgium and Egypt. When one more country signs up, the four signatures necessary for ratification will have been obtained, and then this important treaty will be able to function.

PARADE OF THE ANIMAL KINGDOM.

By Robert Hegner. Assisted by Jane Z. Hegner. The Macmillan Co., New York. $5.00. $10\frac{1}{4}$ x $7\frac{1}{4}$; vi + 675; 1935.

The reader of this delightful contribution to the lively sciences stands on the gangplank of Noah's Ark and watches the animal kingdom file past him, from the lowly *Amoeba* to the almost human gorilla. The last member of the parade is omitted for the obvious reason of lack of space. The animals described include members of each of the large divisions of the animal kingdom, and have been chosen because they are familiar in everyday life or in literature, because they are economically important, or because they are commonly seen in circuses and zoos. The reader learns what they look like, where they live, how they protect themselves, obtain their food, and reproduce and what their effect is on human welfare. Nor is the folklore of animals neglected. The book contains 743 excellent illustrations, most of them photographs of the living animals in their native habitats. There is a detailed index. We know of no more attractive introduction for either children or adults to the fascinating study of our animal cousins.

An Introduction to Comparative Zoology. *A Text-book for Medical and Science Students.*

By F. G. Sarel Whitfield and A. H. Wood. P. Blakiston's Son and Co., Philadelphia. $5.00. 9¾ x 7⅜; x + 354; 1935.

It is the viewpoint of the authors that the usual zoölogy courses and texts are not properly organized and developed from the point of view of the medical student who must, in his preparation, have contact with the subject but should be priviledged to miss certain details and minutiae which are adjudged irrelevant. Accordingly they have written for the medical student the present volume on zoölogy, stressing the evolutionary and comparative viewpoint. Actually, the book seems quite orthodox in its general scope. It is divided into two parts: the first section deals with a phylum-by-phylum review of the principal animal groups, and the second section stresses biological principles—metabolism, heredity, evolution, and ecology. The book does omit much material which could only be superfluous to the young medico and stresses, wherever practicable, the human aspects of the subject. It is rather curious that in the chapter on ecology the entire emphasis is placed on the old "web of life" idea. The text is supplemented by a number of original illustrations which are definitely helpful. There is a brief glossary and an index.

Fauna of the National Parks of the United States. *Wildlife Management in the National Parks. United States Department of the Interior, Contribution of Wildlife Division, Fauna Series No. 2.*

By George M. Wright and Ben. H. Thompson. U. S. Government Printing Office, Washington. 20 cents. 9⅛ x 5¾; viii + 142; 1935 (paper).

Although the title implies that this small book is simply an annotated list of the animals inhabiting our National Parks, inspection of the contents shows this is not the case. The book presents some new life-history data and general observations on the fauna of the Parks, but seems largely interested with the important problem of wild-life conservation and management. This can be stated in the words of the authors, who say: "Viewing the volume as a whole, it is evident that it deals with wildlife management and makes no pretense of presenting new facts in the form of pure zoölogy."

The book is divided into two parts. Part I is entitled, "Perpetuation and utilization of primitive wildlife values," and Part II, "Present status of national parks wildlife and the restoration program."

Naturalists, conservationists, and wildlife administrators will find the book useful.

Les Invertébrés. *Arthropodes, Mollusques et Échinodermes. Actualités Scientifiques et Industrielles, 242. Leçons de Zoologie et Biologie Générale, IV.*

By Georges Bohn. Hermann et Cie, Paris. 18 francs. 10 x 6½; 132; 1935 (paper).

This volume, the fourth of the series dealing with the invertebrates, concerns itself with the arthropods, molluscs, and echinoderms. The book starts off in a conventional manner by discussing the principal characteristics of the phylum Arthropoda and stressing the serial homology between the various arthropod types. Following this are brief considerations of the comparative anatomy of insects and crustaceans; the biology of the crustaceans; the reproduction and development of insects; insect parasites; the instincts of insects; the arachnids; the molluscs and the echinoderms.

In some ways this book is better than its predecessors yet it leaves much to be desired by the serious student of invertebrate zoölogy. These books seem sketchy and leave out much information that should be included. One gets the impression that they have been hurriedly assembled and do not represent the expenditure of great time and energy in their preparation.

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Le Polymorphisme des Males de Coléoptères. *Actualités Scientifiques et Industrielles, 255. Exposés de Biométrie et de Statistique Biologique, VI.*

By Renaud Paulian. Hermann et Cie, Paris. 10 francs. 10 x $6\frac{1}{2}$; 35; 1935 (paper).

Polymorphism among insects is not an infrequent phenomenon. It is especially well exhibited by certain of the beetles, e.g. the Lamellicorns, where the males frequently possess grotesquely produced mandibles and various dorsolateral head excrescences. The author of this short monograph has examined many of these structures biometrically and comes to the conclusion, already prevalent, that the explanation for the multiplicity of form with respect to certain anatomical characters is as yet "far from being explained." He does conclude, however, that the polymorphic structures of the Coleoptera can be divided into two categories; trophic or constant variants, characters which vary little between individuals, and genetic or inconstant variants which display more inter-individual variation. This interesting little book is a worthy addition to the "*Actualités*" series.

Migrations et Métamorphoses de l'Anguille d'Europe. *Actualités Scientifiques et Industrielles, 264. Exposés de Biologie Zoologique, II.*

By Léon Bertin. Hermann et Cie, Paris. 15 francs. 10 x $6\frac{1}{2}$; 57; 1935 (paper).

This is an interesting account of the various stages in the life cycle and the migrations of the European eel. Born in the Sargasso Sea as transparent pelagic larvae called Leptocepheles, they migrate in that stage to the coastal waters of Europe via the Gulf Stream. There they become transparent eels and invade the inland seas and fresh waters. They undergo two other metamorphoses—first into the yellow eel and then into the silver—before starting their reproductive migration back to the Sargasso Sea. It is estimated that they travel at the rate of 13 to 30 kilometers a day, depending upon such factors as length of day, temperature and salinity of the water. The work is illustrated with photographs, drawings, and maps, and has a bibliography of three pages.

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West Coast Shells. *A Description in Familiar Terms of the Principal Marine, Fresh-Water, and Land Mollusks of the United States, British Columbia, and Alaska, Found West of the Sierra.*

By Josiah Keep. Revised by Joshua L. Baily, Jr. Stanford University Press, California. \$3.75. $7\frac{7}{8}$ x $5\frac{5}{8}$; xi + 350; 1935.

The first edition of this minor classic appeared in 1887, and two revisions have preceded the present one which brings up to date the nomenclature and descriptions of species of marine shells ranging from Alaska to San Diego, and of land and fresh-water forms in Washington, Oregon and California. There are 334 figures—pen and ink drawings—to aid in identification. The index lists specific and varietal names alphabetically under the genera. The book is written in an informal, interesting style and the student of conchology may well thank Mr. Baily for this careful revision of a useful handbook.

Frogs, Toads, and Salamanders. *Science Guide for Elementary Schools, Volume 1, Number 6.*

By Edith A. Pickard. Division of Textbooks and Publications, California State Department of Education, Sacramento. 15 cents. 9 x 6; iii + 55; 1935 (paper).

This is a guide for teachers in the grade schools who know little about biology but wish to awaken some interest for natural science in their pupils. Special reference is made to California species of amphibians, but the guide can be used with advantage in any locality. The life histories and characteristics of the amphibians are briefly outlined. Directions for making a vivarium and a few simple experiments to perform on the living frog are suggested. The pamphlet should be helpful.

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Familiar Birds of the Pacific Southwest *with Size and Color Key.*

By Florence van V. Dickey. Stanford University Press, Stanford University, Calif. $3.75. 6¾ x 4¾; lviii + 241; 1935.

This book was written with the sole object of enabling the amateur to identify birds easily and quickly. By noting the size in comparison to a few well-known birds and the predominant color, one can make a fair shot at naming 201 birds. Short descriptions of many birds are given and there are over 100 beautifully colored plates. There is a good index and a check list of scientific and common names.

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A Manual of Land and Fresh Water Vertebrate Animals of the United States *(Exclusive of Birds). Second Edition.*

By Henry S. Pratt. P. Blakiston's Son and Co., Philadelphia. $6.00. 9 x 6; xvii + 416 + folding map; 1935.

The main purpose of the revision of this Manual has been to reflect in it the numerous changes in the nomenclature of the vertebrate animals of the United States which have been made in the past few years, and to define more precisely their known ranges of distribution. Dr. Emmett Reid Dunn, Professor of Biology in Haverford College, has thoroughly revised the sections on Amphibians and Reptiles.

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Entomology. *With Special Reference to Its Ecological Aspects. Fourth Revised Edition.*

By Justus W. Folsom. Revised by R. A. Wardle. P. Blakiston's Son and Co., Philadelphia. $4.00. 8¾ x 5¾; ix + 605; 1934.

This fourth edition has been prepared by Professor Wardle. While no changes have been made in the basic structure of the book and those features in the previous editions which appealed to teachers and students have been retained, a great amount of new matter has been interpolated throughout and several chapters have been remodeled, notably those dealing with Insects and Disease and Insects and Man.

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The Juvenal Plumage and Postjuvenal Molt in Several Species of Michigan Sparrows. *Bulletin No. 3.*

By George M. Sutton. Cranbrook Institute of Science, Bloomfield Hills, Mich. 50 cents. 9 x 6; 36 + 8 plates; 1935 (paper).

The author defines and describes more clearly than has heretofore been done the juvenal and postjuvenal plumage in birds. His discussion is based on observations made during a six-weeks study of bird life on the Edwin S. George Wild-Life Reserve. There are excellent descriptions and illustrations of the plumage of eleven different species of sparrows.

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The Spruce Budworm on Michigan Pine. *University of Michigan, School of Forestry and Conservation, Bulletin No. 6.*

By Samuel A. Graham. University of Michigan Press, Ann Arbor. 25 cents. 9 x 6; 36; 1935 (paper).

This bulletin describes briefly the recent rather serious outbreaks of the spruce budworm which is now attacking the jack pine in the Lake States. In some detail the life history of the insect, the influence of environment on the population, and specific measures for future control are discussed.

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Animalium Cavernarum Catalogus. *Pars 2, 3, 4, 5, 6.*

By Benno Wolf. W. Junk, Berlin and 's-Gravenhage. Single copy 18 marks (Holland: Fl. 10.60); subscription price 13.50 marks (Holland: Fl. 8). 10 x 7¼; 128 pages each; 1934–1935 (paper).

The first number of this thorough and systematic catalogue of the cavern fauna of the world was noticed in Volume 10, page 104 of this Review. These numbers include lists of authors from Ch to No; caves in Germany, France, Greece and Italy; and the phylum Arthropoda.

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A Classification of Fishes. *Including Families and Genera as Far as Known. Stanford University Publications, Biological Sciences, Volume III, Number 2.*

By David Starr Jordan. Stanford University Press, California. $3.50 (paper); $4.25 (cloth). 10 x 6⅞; 163 + x, 1934 (second printing by photolith).

This is a photolithographic reprint of a well-known work, originally published in 1923, by one of America's greatest ichthyologists.

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The Mangrove Warbler of North-Western Mexico. *Transactions of the San Diego Society of Natural History. Volume 8, Number 10.*

By A. J. van Rossem. Society of Natural History, San Diego, Calif. 10⅛ x 6¾; 2; 1935.

A New Race of Brown Towhee from the Inyo Region of California. *Transactions of the San Diego Society of Natural History, Volume 8, Number 11.*

By A. J. van Rossem. Society of Natural History, San Diego, Calif. 10⅛ x 6¾; 3; 1935.

A New Silky Pocket Mouse from Sonora, Mexico. *Transactions of the San Diego Society of Natural History, Volume 8, Number 12.*

By Laurence M. Huey. Society of Natural History, San Diego, Calif. 10⅛ x 6¾; 2; 1935.

A New Subspecies of Crotalus Confluentus, the Prairie Rattlesnake. *Transactions of the San Diego Society of Natural History, Volume 8, Number 13.*

By Laurence M. Klauber. Society of Natural History, San Diego, Calif. 10⅛ x 6¾; 13 + 1 plate; 1935.

New or Little Known Crabs from the Pacific Coast of Northern Mexico. *Transactions of the San Diego Society of Natural History, Volume 8, Number 14.*

By Steve A. Glassell. Society of Natural History, San Diego, Calif. 10⅛ x 6¾; 20; 1935.

A New Genus and Species of Pigmy Goose from the McKittrick Pleistocene. *Transactions of the San Diego Society of Natural History, Volume 8, Number 15.*

By Roland C. Ross. Society of Natural History, San Diego, Calif. 10⅛ x 6¾; 7; 1935.

BOTANY

Weeds.

By Walter C. Muenscher. The Macmillan Co., New York. $6.00. 8½ x 5⅝; xxii + 577; 1935.

If a large-scale campaign of weed eradication or control is to be both effective and economical the first step, according to Muenscher, should be the identification of the offending plant for the purpose of facilitating the selection of the most vulnerable part of the plant against which to launch an attack. He has skillfully adapted this reference book to the needs of people in diverse walks of life who have to contend with plants that grow where they are not wanted. While it can be most readily used by people with botanical training a series of more than a hundred excellent drawings make it possible to find the names of more than that number of plants merely by leafing through the book. There is a dichotomous key based on morphological characters for the identification of 500 common weeds infesting the northern part of the United States. Each species has a botanical description, notes on its distribution and the kind of situation in which it is likely to be troublesome, and recommendations for eradication or control. Most of the species and practically all of the genera are represented by excellent drawings showing the mature plant, flower, seed, seedling, and any other organs important in propagation. The excellent introductory sections, covering 90 pages, discuss the special characteristics of weeds, the weeds of special habitats, the control of weeds by means of the usual agricultural practices, and the control of weeds by chemical means. There is a very good index, an extensive bibliography and an adequate glossary.

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Chronica Botanica. *Volume I.*

Edited by Fr. Verdoorn. Chronica Botanica, P. O. Box 8, Leiden, Holland. 15 Neth. guilders. $9\frac{1}{2}$ x $6\frac{1}{4}$; 447; 1935.

In this year-book plant science has a new and unique annual, about which Professor E. D. Merrill, in an introductory chapter says:

> The "Chronica Botanica" as conceived covers a field not hitherto preëmpted, conflicts with no established periodical, supplements those already in existence, and should, by its very nature, encourage the spirit of international coöperation, a spirit characteristic of this our science, of which we, as botanists representing all nations, are individually and collectively proud.

The chief feature of the new year-book is a review of the important current research in all branches of plant science—agronomy, forestry, horticulture, microbiology, soil science, agricultural chemistry, etc.—throughout the world. Other features are: Illustrated professional and personal news of the past year, with notes about future events; an index of main acquisitions of herbaria, botanic gardens, etc.; reports and notes on the societies and congresses; an exhaustive and up-to-date list of institutions, societies and workers in plant sciences, with complete addresses. There is an index of plant names and plant parasites and an index of persons.

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The Algae and Their Life Relations. *Fundamentals of Phycology.*

By Josephine E. Tilden. University of Minnesota Press, Minneapolis. $5.00. $9\frac{1}{4}$ x $5\frac{7}{8}$; xiii + 550 + 1 plate; 1935.

The need for a textbook in the field of phycology has been a crying one. This is well pointed out by Doctor Tilden, who says in the preface to her book:

> Phycology offers an enormously stimulating field for research, but the teaching of it is likely to have results that are far from satisfactory. At present there is no textbook that will do duty as a guide to the student and at the same time supplement the lectures and the laboratory and field work which a conscientious teacher feels should be made available to him. Reference books for experienced investigators are not lacking; among recent publications in this country and abroad are several excellent works dealing exhaustively with some special phase of the field, such as blue-green algae, green algae, fresh-water algae, and taxonomic studies of individual groups of algae. No textbook is obtainable, however, which answers for the thinking student the questions, Are there connecting links between the several classes of algae? Is there a relationship between any of the classes of algae and the higher plants, or between the algae and the primitive or the higher animals? What is the probable place of origin or point of unusual development of any particular algal group with respect to the geological history of the world?
>
> . . . The object in preparing the present volume has been to offer to teachers and students material arranged in orderly fashion, on the basis of which any desired course may be planned. Terms have been simplified and reduced in number; a series of life cycle diagrams have been included with the object of clarifying many things that in the past have seemed meaningless. The key to the system of arrangement and classification is based on a limitation of the use of the term "spore."

In the opinion of the reviewer this book meets the problems and ideals discussed in the preface and will undoubtedly be welcomed by botanists generally. The book is well illustrated and has a bibliography and an index.

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A Textbook of Bacteriology.

By Thurman B. Rice. W. B. Saunders Co., Philadelphia. $5.00 net. $9\frac{1}{4}$ x 6; 551; 1935.

In his practice the clinician frequently wishes to review certain points about medical bacteriology. He may wish to merely learn the latest and accepted name of an organism, or he may want quick and practical advice on the availability and efficacy of specific biological products in the treatment of a malady. This book is designed to help the clinician deal with such problems by summarizing much of the existing knowledge on the bacteriology of disease. The author attempts to give the following information about the more important diseases: historical remarks; morphological and cultural characteristics of the organism; pathogenicity and lesions produced; specific biological products and their value in treatment, and prophylactic measures. There are also chapters on bacterial culture technique and the theoretical aspects of immunity. A few illustrations and an adequate index are to be found but there is no bibliography. The book should find supporters among the group for which it was written.

BRITISH STEM- AND LEAF-FUNGI (COELOMYCETES). *A Contribution to Our Knowledge of the Fungi Imperfecti Belonging to the Sphaeropsidales and the Melanconiales. Volume I. Sphaeropsidales. To the end of the Sphaerioideae which have colourless or nearly colourless spores.*

By W. B. Grove. The University Press, Cambridge; Macmillan Company, New York. \$7.00. $8\frac{1}{2}$ x $5\frac{1}{4}$; xx + 488; 1935.

Students of the Fungi Imperfecti will welcome the appearance of this monograph. Many North American species are included.

> The present volume includes all the British Sphaeropsidales to the end of the Scolecosporae; the remainder of them and the Melanconiales, which embrace species of greater beauty and complexity, will form a second volume of about the same size.
>
> The account given of each species is in the main purely morphological; few pathological or cultural details are included, except very briefly. This is intentional. The two departments of Mycology, as experience many times has shown, are best treated by specialists, but working in happy conjunction.

Description of each species is accompanied by critical taxonomic notes, ecological data, and the name of the host plant on which it has been found. There is an index of the genera of host plants mentioned in this book and an index to the fungi described. Latin descriptions of 24 new species are given in an appendix.

EVOLUTION OF FOLIAR TYPES, DWARF SHOOTS, AND CONE SCALES OF PINUS *With Remarks Concerning Similar Structures in Related Forms. Illinois Biological Monographs, Vol. XIII, No. 3.*

By Clifton C. Doak. University of Illinois Press, Urbana. \$1.50. $10\frac{3}{8}$ x $6\frac{3}{4}$; 106; 1935 (paper).

A study of the axial and foliar systems of about thirty-five species of pines and of a few related plants. The ontogeny of the cotyledons supports the view that polycotyledony is a primitive character and that fusions, incorporations, and reductions mark advances. A technique is described whereby the number of bud scales and of sterile bracts can be approximately determined prior to extension of the buds which contain them. The technique is utilized in following the time of origin of units within the bud. Most of the unique vegetative characters of *Pinus* can be directly or indirectly attributed to influences incident to the formation of the compound bud. This structure relieved the sheath scales from the work of meristematic protection and permitted specialization along other lines. It necessitated the almost simultaneous development of many structures from stored food and exerted shaping pressures upon the enclosed immature dwarf shoots.

Numerous illustrations, diagrams, tables, and a bibliography of 105 titles, are included in the study.

CACTUS GROWING FOR BEGINNERS.

By Vera Higgins and H. T. Marrable. The Blandford Press, London. 2s. 6d. net. $7\frac{1}{4}$ x $5\frac{7}{8}$; 84; 1935 (paper).

Mrs. Higgins, an expert in cactus growing, has enlisted the aid of an amateur in the field "who has made every mistake a beginner could make, and who should therefore be in a position to appreciate just how much and how little a beginner knows," in the preparation of this handbook for members of the English Cactus and Succulent Society and other cactus raising fans and collectors. Descriptions are given of the more common types of cacti, with detailed instructions for their cultivation in homes and greenhouses. In a final chapter, "Summary of Operations," is reviewed the work to be done with these remarkable plants at different seasons of the year. The booklet is adequately indexed.

◆

A Textbook of General Bacteriology. *Eleventh Edition, Entirely Reset.*

By Edwin O. Jordan. W. B. Saunders Co., Philadelphia. \$6.00. $9\frac{1}{8}$ x $5\frac{5}{8}$; 825; 1935.

Although a new chapter on bacterial variation has been added and many portions have been rewritten to bring it up to date, this well-known standard textbook remains much the same as in earlier editions. It presents a very comprehensive survey of bacteriology assuming no knowledge on the part of the reader. While the bulk of the book is concerned with forms pathogenic to man, there are also chapters on the nitrogen cycle, bacteria in industry, bacteria of the air, soil, and water, and bacterial diseases of plants. There is an excellent index subdivided into "authors" and "subjects." A fair number of references are given as footnotes, but there is no general bibliography.

◆

The Herbaceous Flowering Plants (*Exclusive of Grasses and Sedges*) *Growing Without Cultivation in the Vicinity of Orono, Maine. University of Maine Studies, Second Series, No. 34.*

By Eugene C. Ogden. The University Press, Orono, Maine. \$1.00 (bound); 50 cents (paper). $8\frac{7}{8}$ x $5\frac{3}{4}$; 77; 1935.

This "annotated list of the herbaceous flowering plants (exclusive of grasses and sedges) which have been found growing without cultivation within the towns of Old Town, Orono, Veazie, Bradley, and Milford, including some plants which though considered woody might be looked for in this list," is based on the recent collections of the author and upon examination of specimens in the Gray Herbarium and other herbaria. Brief taxonomic and ecological notes accompany the list of 623 plants. There is a topographic map of the region and there is an index of popular and scientific names.

◆

Hvalrådets Skrifter. *Scientific Results of Marine Biological Research. Nr. 10. The "Qst" Expedition to the Denmark Strait 1929. II. The Phytoplankton and its Conditions of Growth (Including Some Qualitative Data from the Arctic in 1930).*

By Trygve Braarud. Edited by Universitetets Biologiske Laboratorium. Jacob Dybwad, Oslo. $10\frac{3}{4}$ x 7; 173; 1935 (paper).

This publication includes a very thorough discussion of the different factors governing phytoplankton production in the sea, emphasis being placed on the factors which influence the number of plants. A description is given of the vegetation and conditions of plant production in the Atlantic, Arctic and Polar water masses of the Denmark Strait. A list of all species is given together with valuable notes on their distribution and taxonomy.

◆

Plant Viruses.

By Kenneth M. Smith. Methuen and Co., London. 4 shillings net. $6\frac{3}{4}$ x $4\frac{1}{4}$; ix + 107; 1935.

In this little volume (of the series of Methuen's Monographs on Biological Subjects) is presented in a brief but understandable way some of the more interesting and important facts concerning plant viruses. Botanists and entomologists will find problems of fundamental importance in their own field such as the "affinities of viruses with enzymes, their intimate relationship with the living cell, their curious and interesting association with insects, and finally the possibility that they may represent a new and simple form of life." The volume is illustrated, contains a list of 94 references and is indexed.

* * *

AMERICAN FERNS. *How to Know, Grow and Use Them.*
By Edith A. Roberts and Julia R. Lawrence. The Macmillan Co., New York. $2.50. 9¼ x 6⅛; viii + 98; 1935.

This book tells how to identify ferns, how to raise them from spores, and which ones are best for use in various types of gardens. It contains many beautiful photographs and a good index.

MORPHOLOGY

PRINCIPLES OF INSECT MORPHOLOGY.
By R. E. Snodgrass. McGraw Hill Book Company, New York. $6.00. 7⅞ x 5¾; ix + 667; 1935.

Not so very long ago insect morphology was a comparatively unexplored science. Entomologists were familiar, of course, with the general principles of insect structure but little knowledge was available about the finer anatomical details. This book by Doctor Snodgrass serves the twofold purpose of putting insect anatomy on a respectable basis and of integrating much of the work done by recent investigators. Just as students of human anatomy refer to "Gray," entomologists will find themselves seeking "Snodgrass" when they wish information on some detail of insect anatomy. It is not the purpose of the reviewer to imply that the present volume is complete in the sense that all structural systems are perfectly worked out. This is not the case; there still remains much work to be done. The book, however, is an important advance towards that end.

The subject matter is presented in a standardized but effective manner. Typically, a chapter is devoted to a particular structural system although in some instances more space is needed. The functional viewpoint is admirably stressed so that the reader gets a good idea of the use of structures as well as an understanding of their anatomy. A glossary of terms applying to the material just discussed is appended to each chapter. A selected bibliography, an index, and many illustrations increase the value of the text.

This book is a welcome and important addition to zoölogical literature.

* * *

ELEMENTARY MICROTECHNIQUE.
By H. Alan Peacock. Longmans, Green and Co., New York. $1.90. 7¼ x 4⅞; vii + 200; 1935.

A book designed primarily for beginning students of histology and cytology with the purpose of filling the gap between the instruction sheets of the classroom and the larger reference volumes. A brief résumé of the structure of the cell and protoplasm and short descriptions of the processes of microtechnique and the principles they involve are followed by a chapter outlining methods and technique. Included here in tabular form are notes on the general character, use and effects of about twenty of the most commonly used fixatives. Listed alphabetically and quite adequately for their purpose in three separate chapters are: (1) subjects for special study with the steps of various methods to be followed in their preparation; (2) stains and their uses; (3) formulae and hints. There is an index and three appendices, including a bibliography, information on the sources and culture of several materials, and methods for the preservation of materials.

* * *

THE MICROSCOPIC ANATOMY OF VERTEBRATES.
By George G. Scott and James I. Kendall. Lea and Febiger, Philadelphia. $3.75. 9¼ x 5½; 306; 1935.

A college textbook designed to accompany laboratory work in the field of vertebrate histology and microscopic anatomy, the work to be covered in one semester. After an introductory chapter on the cell and embryology the topics treated are: epithelial tissues; connective tissues; blood; muscle tissues; nerve tissue; vascular system; lymphatic system; integument; respiratory system; digestive system; excretory system; female reproductive system; male reproductive system; and endocrine glands. The final chapter gives detailed information on technique. A list of references is given at the end of each chapter and in an appendix will be found lists of current references, anatomical and histological texts, also a lengthy list of prepared slides to be used in the course. The volume is well illustrated and is indexed. A highly useful book for teaching purposes.

THE ANATOMY OF THE NERVOUS SYSTEM. *From the Standpoint of Development and Function. Fifth Edition, Revised.*

By Stephen W. Ranson. W. B. Saunders Co., Philadelphia. \$6.50. $9\frac{7}{8}$ x $6\frac{1}{2}$; 501; 1935.

Recent work in neurology has made necessary a revision of many of the important concepts presented in the earlier editions of this useful text. However, the complexity and mass of material has not been extended, as the author feels that the student of neurology can absorb only very definite amounts of detail. The most important change has been in the part discussing the central visual pathway. The text in this revised form is certainly one of the most accurate and easily comprehendible texts available for medical students.

INTRODUCTION TO VERTEBRATE EMBRYOLOGY. *A Textbook for Colleges and Universities. Third Edition, Revised and Enlarged.*

By Waldo Shumway. John Wiley and Sons, New York. \$4.00 net. 9 x $5\frac{3}{4}$; xii + 390; 1935.

The first edition of this successful textbook was reviewed in Vol. 3, No. 1, and the second edition in Vol. 6. The first half of the text in this new edition has been entirely reorganized and rewritten. In fact the only section that has remained in its old form (except for the addition of some new illustrations) is Part III dealing with organogeny.

PHYSIOLOGY AND PATHOLOGY

SIX CONFÉRENCES DE PHYSIOLOGIE.

By Léon Binet. Masson et Cie, Paris. 12 francs. $9\frac{3}{4}$ x $6\frac{3}{4}$; 73; 1935 (paper).

LEÇONS DE PHYSIOLOGIE MÉDICO-CHIRURGICALE.

By Léon Binet, with the collaboration of MM. Arthus, E. Benhamou, R. Fabre, J. Haguenau, Mme C. Jeramec, MM. J. Gosset, M. Kaplan, J. Marie, J. Patel, A. Sicard, and M. Sureau. Masson et Cie, Paris. 40 francs. $9\frac{3}{4}$ x $6\frac{3}{4}$; 245; 1935 (paper).

The first of these books by a distinguished physiologist contains six lectures delivered before the Faculty of Medical Sciences at Buenos Aires, in August and September, 1934. The titles are: (1) What is a lung?; (2) New biological and therapeutic investigations on asphyxia; (3) Adrenals and glutathione; (4) Provoked hyperthermia (humoral syndrome); (5) Some investigations on nerve; (6) The biologically reactive fish.

The second is a collection of lectures presented by the author and some of his colleagues in a weekly course inaugurated by him in the hospital services of Paris. A wide range of topics was offered. Included among them were reanimation; the physio-pathology of arterial embolism; the functional exploration of the spleen; acute nephritis; the biological diagnosis of pregnancy. The general impression we get is that the meetings must have been highly successful and stimulating.

In the first of these books each lecture is provided with a bibliography; in the second some are documented. Both are illustrated.

A CONTROLLED EXPERIMENT ON RURAL HYGIENE IN SYRIA. *A Study in the Measurement of Rural Culture Patterns and of Social Forces.*

By Stuart C. Dodd. American University, Beirut, Lebanon. \$2.00 net. $9\frac{3}{8}$ x $6\frac{1}{4}$; xv + 336 + 12 plates and folding map; 1934 (paper).

This is the report of an investigation which had for its main object the development of a method of measuring the hygienic conditions of Syrian villages. The means by which the information was obtained, the form of questionnaire used and the estimation of errors are discussed in great detail. Praiseworthy are the efforts of the author to determine and measure the errors which might affect the reliability of his results, but the statistical analysis is perhaps excessively refined considering the nature of the material and size of samples.

The author's method received practical application in an attempt made to measure the effect of health instructions on hygienic conditions. Four Syrian villages were surveyed and the hygienic status of the inhabitants measured. One village was selected as experimental and for two years the natives were given instructions by an itinerant clinic.

After this period the experimental village and the three control villages were resurveyed. This second survey showed that the experimental village had made a progress estimated at 20 per cent, while the average score of the control villages had gained by 18 per cent. This equal progress, which is regarded as statistically significant, according to the author is due to the fact that the inhabitants of the control villages were in some contact with those of the experimental village and therefore benefited by the instructions given in the latter. The question that one would like answered at this point is: Did the morbidity actually decrease in these villages?

* * *

Le Secr deet la Vie. *Les Ondes cosmiques et la Radiation vitale. Deuxième édition revue et augmentée de "L'Origine de la Vie."*
By Georges Lakhovsky. Gauthier-Villars et Cie, Paris. $7\frac{3}{4}$ x $5\frac{5}{8}$; xxi + 261 + 6 plates; no date (paper).

L'Oscillation Cellulaire. *Ensemble des Recherches Expérimentales.*
By Georges Lakhovsky. Gaston Doin et Cie, Paris. 40 francs. $9\frac{1}{2}$ x $6\frac{1}{4}$; 319; 1931 (paper).

According to Lakhovsky every cell contains elements of oscillating electric circuits which absorb and emit electromagnetic radiations. Health and disease are dependent upon the equilibrium or disequilibrium between the rays absorbed and the rays emitted. This theory was first put forth at length by him in *L'Origine de la Vie* noticed in Volume 3, page 433 of this Review. The first of the books noticed now is a second, augmented edition of this work. Three chapters have been added: Influence of sun spots on life and health; Influence of the nature of the soil on the field of cosmic rays: Contribution to the etiology of cancer; and the therapeutics of cellular oscillation.

The second book is a collection of papers by the author and reviews of his work by Auguste Lumière, Attilj, Rivera and other workers who are apparently sympathetic with Lakhovsky's theory. The discussions on cancer are amplified to a greater extent than in the *Secret de la Vie*. They are more interesting than convincing.

* * *

Celsus de Medicina. [In two volumes]. *Volume I.*
With an English Translation by W. G. Spencer. Harvard University Press, Cambridge. \$2.50 (cloth); \$3.50 (leather). $6\frac{1}{2}$ x $4\frac{1}{4}$; xiv + 499; 1935.

Nobody knows much about who or what the person who wrote this treatise was. It is not certain that he ever practised medicine, or had any closer relation to it than to write extremely well about it. It has indeed been suggested that Celsus only translated and adapted a pre-existing Greek treatise, perhaps by Cassius, perhaps by Titus Aufidius Siculus, who was a pupil of Asclepiades. But in any case it is an extremely interesting book. It starts off with an excellent, if brief, history of medicine up to the time (roughly the reign of Tiberius). This is followed by general considerations of disease and treatment, and in turn the discussion of particular diseases. The first four books are included in this volume, to be followed by a second completing the work.

The translation and notes are excellent, satisfactorily maintaining the high standards of the Loeb Classical Library. It will be a valuable addition to any medical or biological library.

THE DISEASES OF THE ENDOCRINE GLANDS.

Third Edition, Revised and Enlarged.

By Hermann Zondek. Translated by Carl Prausnitz. William Wood & Co., Baltimore. $11.00. $9\frac{1}{2}$ x $6\frac{1}{2}$; xi + 492; 1935.

This book is an English translation of the third German edition. The scope of the volume can be expressed in the author's own words:

> It was not so much my aim to make the book a compendium of all the physiological data and opinions comprised in the enormously developed subject of endocrinology; rather was it my intention that it should remain what it had been in the past: primarily a book for the clinician.

The text is divided into two sections: part I, a general discussion about the physiology, pharmacology and interrelations of the endocrines and their hormones, and part II, a discussion of specific pathologies and diseases due to endocrine aberrations.

This is a scholarly and workable text on clinical endocrinology and its appearance in English is welcome. The author is admirably wary of advocating radical and untested methods of treatment for glandular disorders. For this reason, the book is an important opponent of the "quack" type of endocrinology which is all too prevalent today. There is a detailed bibliography and a useful index.

A NEW ANGLE ON HEALTH. (*Nature's Provision for the Health and Happiness of Mankind*).

By D. H. C. Given. John Bale, Sons and Danielsson, London. 7s. 6d. net. $9\frac{1}{2}$ x 6; xvii + 160 + 5 plates and 3 folding tables; 1935.

As far as the reviewer can perceive the thesis of this book runs as follows: With civilization the human race has so altered its biological environment that two great categories of diseases have sprung up, the "diseases of poverty" and the "diseases of riches." The former are the result of inadequate living and social conditions, e.g., overcrowding, malnutrition, insufficient sunshine, etc. The latter result from "self-indulgence before temperance" where certain organs are overworked and others are underworked, thus throwing the body "out of gear." The author claims that about 80 per cent of the total mortality is directly or indirectly attributable to these two "diseases." The remedy lies first in simply altering, improving and intellectualizing conditions among both rich and poor, and, second, in the words of the Bible and the author, "Seek ye first the kingdom of God (meaning Nature, God's kingdom upon earth) and all these essential things will be added unto you." A naïve book.

EXPERIMENTAL PHYSIOLOGY. *With Anatomical and Mechanical Illustrations and an Appendix of Technical Data.*

By Maurice B. Visscher and Paul W. Smith. Lea and Febiger, Philadelphia. $3.25. $9\frac{1}{4}$ x $5\frac{7}{8}$; 191; 1935.

In this book laboratory experiments in general and mammalian physiology are outlined for the medical student. Many of the experiments are classical in nature and, as the authors point out, are not included because of especial originality but because of their importance in the understanding and interpretation of animal function. Exercises are outlined which cover such topics as the general properties of protoplasm, and the mechanism of muscular activity, circulation, respiration, nervous activity, digestion, metabolism and excretion. The book is tersely written, the assumption presumably being that the student using it will have both a considerable background in physiology and opportunity for facile consultation with his instructors. A pertinent reference at the end of each experiment aids the student in collateral reading if he so desires. There is an appendix of useful formulae and an adequate index.

Public Health Administration in the United States.

By Wilson G. Smillie. The Macmillan Co., New York. \$3.50. $9\frac{1}{4}$ x $6\frac{1}{8}$; xvi + 458; 1935.

A timely and highly useful book. The author has compiled "the material that is available concerning the administrative aspects of public health organization and procedure and has attempted to correlate one activity with another, and fit each into its proportionate place; to present an analysis of present practices, and suggest probable future developments." It is pointed out that public health work must always be dynamic—not static—and that this book is not to be regarded as an authority but simply as a guide. The main part of the volume is divided into three sections. The first deals with administrative control of communicable diseases that are commonly encountered in public health practice; the second with basic activities of a health organization; and the last with organization of public health programs. Figures, graphs and charts illustrate salient points in the book. A list of references accompanies each chapter and a detailed index is given.

Nutrition Work with Children. *Revised and Enlarged Edition.*

By Lydia J. Roberts. University of Chicago Press, Chicago. \$3.50. $8\frac{1}{4}$ x $5\frac{1}{2}$; xix + 639; 1935.

The advances made in nutritional fields have been so great in the last decade that the author has found it necessary to develop a new and completely revised edition of this book in order to bring the material up to date and to correct certain errors of the first edition. The following new discussions have been added: first, a consideration of the effects of the depression on nutrition and health; second, a consideration of the distinctions between the adequate and optimal nutrition of children; third, an expansion of the discussion on the mental effects of undernutrition; fourth, a discussion of high school health problems, and, last, a critique of the rôle played by various national and local agencies and programs in affecting the health and nutrition of children.

This book is well written, contains detailed bibliographies following each chapter, and is thoroughly scientific in its viewpoint.

The Physiology of Domestic Animals. *Third Revised Edition.*

By H. H. Dukes. With a chapter on The Physico-Chemical Basis of Physiological Phenomena, by E. A. Hewitt. A part on Reproduction, by G. W. McNutt. Comstock Publishing Co., Ithaca, N. Y. \$6.00. 9 x 6; xiv + 643; 1935.

The first two editions of this book were lithoprinted. The demand for the text has been sufficient to bring the book out as a printed edition and to change its format generally. The material has been thoroughly revised by altering and rewriting much of the text and by changing a number of the illustrations. The aims and scope of the book, however, remain fundamentally unchanged. The book has been designed primarily to serve as a reference volume for the veterinarian although it should be useful, in many cases, to the student of general vertebrate physiology. The new edition is well indexed and illustrated and includes a pertinent bibliography after each chapter.

Angines Lympho-Monocytaires, Agranulocytose, Leucémies Leucopéniques.

By Jean Sabrazès and René Saric. Masson et Cie, Paris. 40 francs. $9\frac{3}{4}$ x $6\frac{1}{2}$; 363; 1935 (paper).

This is a detailed description of three distinct clinical syndromes: mononucleoses, agranulocytoses and aleukemic leukemias, which, however, have a number of signs and symptoms in common. Each of the three syndromes is considered in a separate section in which the authors discuss the history, symptomatology, clinical forms, hematology, anatomic lesions, bacteriologic and experimental investigations, therapy. In addition, throughout the text there are interspersed typical case histories taken from the authors' own practice.

For a subject that is undergoing such rapid progress, the review of the more important world literature here found is really excellent. Special credit should be given to the attempt to coordinate into one system the viewpoints of the several investigators in this field.

THE WOMAN ASKS THE DOCTOR.

By Emil Novak. The Williams and Wilkins Co., Baltimore. \$1.50. 8 x $5\frac{1}{4}$; x + 189; 1935.

This is an exceedingly careful and thoughtfully written book for lay consumption. Thirty years of gynecological practice have well fitted the author to write a book which will answer many of the questions which occur to a woman at some time during her life. The first nine chapters are devoted to different aspects of menstruation. Chapter ten is entitled "Woman as an Egg Producer" and discusses among other things the "safe period," in which the author has a considerable amount of belief. The last chapters discuss such things as common disorders of menstruation, sterility in women, and cancer.

CLINICAL PARASITOLOGY AND TROPICAL MEDICINE.

By Dámaso de Rivas, in collaboration with Carlos T. de Rivas. Lea and Febiger, Philadelphia. \$5.00. $9\frac{1}{4}$ x $5\frac{5}{8}$; 367; 1935.

A useful volume for the student and practitioner. Written primarily as a textbook, the authors' aim has been to present accepted facts concerning the modern conceptions of tropical and parasitic diseases from the standpoint of etiology, the complete life history of parasites, the pathology, symptomatology, diagnosis and treatment of these affections. For the sake of brevity theories and speculations have been eliminated. The volume is well illustrated and includes a list of references to the texts and articles drawn upon, and an index.

THE INFLUENCE OF CONCOMITANT ACTIVITY AND FATIGUE UPON CERTAIN FORMS OF RECIPROCAL HAND MOVEMENT AND ITS FUNDAMENTAL COMPONENTS. *Comparative Psychology Monographs, Vol. 11, No. 4, Serial No. 54.*

By David P. Boder. Johns Hopkins Press, Baltimore. \$1.75. 10 x $6\frac{7}{8}$; 121; 1935 (paper).

The investigator was able to record four different components of the process of tapping with an extended index finger or tool. These components he lists as: "(1) The movement up, (2) the upper reversal, (3) the movement down, (4) and the bottom reversal." He discusses at length variability in the "tapping pattern," as to rate and form of the stops.

THE CONQUEST OF DEATH. *An Imminent Step in Evolution.*

By Annie C. Bill. A. A. Beauchamp, Boston. \$3.00. $7\frac{3}{4}$ x $5\frac{1}{4}$; 432; 1935.

The essential thesis of this prolix work is that, since death is not a natural phenomenon inherent to cell life, man can conquer it by somehow (not very clearly stated) obtaining a period of "organized conscious endeavor."

GESUNDES LEBEN.

By F. Külbs. Georg Thieme, Leipzig. 4.80 Marks. $8\frac{3}{4}$ x $5\frac{3}{4}$; 203; 1935.

The author endeavors to give a few simple rules of hygiene for the instruction and guidance of the layman. Diet, exercise, and rest are treated with most emphasis, and nothing new is pointed out. To the ordinary American, who is very hygiene conscious, the book will appear merely sensible and obvious, but for the European many current health fads are exploded.

LES IONOGRAMMES DE LA CONTRACTION MUSCULAIRE (*Technique d'enregistrement et résultats*). *Actualités Scientifiques et Industrielles, 245. Exposés de Biologie Générale en rapport avec la Cytologie, IV.*

By M. Dubuisson. Hermann et Cie, Paris. 12 francs. 10 x $6\frac{1}{2}$; 34; 1935 (paper).

This is a description of methods of recording graphically the electric phenomena in muscular contractions. The resistance of ionized spaces of the muscle does not appear to change during contraction. However, the resistance of polarized interphases is modified. A short bibliography is provided.

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KREBS *im Lichte biologischer und vergleichend anatomischer Forschung. II. Band, 2. Heft: Adenomkrebs, Kystom, Scirrhus, Bindegewebe, Mesenchym, Sarcom, Odontom, Kieferkystom.*
By Jos. Lartschneider. Franz Deuticke, Leipzig and Vienna. 7 marks. $7\frac{3}{4}$ x $5\frac{1}{2}$; 197; 1935 (paper).

Earlier parts of this work have already been noticed in this REVIEW (Volume 9 Number 3, and Volume 10, Number 2). In this part cancers of the connective tissues, mesenchyme, and the jaw are discussed. The volume is equipped with index, bibliography and illustrations.

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INDIVIDUAL EXERCISES. *Selected Exercises for Individual Conditions.*
By George T. Stafford, Harry B. DeCook and Joseph L. Picard. A. S. Barnes and Co., New York. \$1.00. 9 x 6; ix + 111; 1935 (paper).

This book emphasizes the importance of exercise to attain maximum health. One hundred exercises are described and illustrated. They are suggested in various combinations for fifteen types of physical defects.

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HEALTH AND EFFICIENCY HOLIDAY ANNUAL.
Published by Athletic Publications, Ltd., Link House, London. 1 shilling. 11 x $8\frac{1}{2}$; 63; 1935 (paper).

Directions for planning a holiday, nude or clothed, on a bicycle, in a caravan, at the seashore, in a boat, or camping.

QUARTERLY BULLETIN OF THE HEALTH ORGANISATION. *Volume IV, Nos. 1 and 2. Health Organisation, League of Nations, Geneva; World Peace Foundation, 8 West 40th St., New York.* Annual subscription \$2.50; separate issues 65 cents. $9\frac{1}{2}$ x $6\frac{3}{8}$; 192; 1935 (paper).

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BIOCHEMISTRY

TRAITÉ DE CHIMIE ORGANIQUE. *Tome I. Analyse Organique, Azéotropisme et Distillation, État Cristallin et État Colloïdal, Composé Défini et Corps Pur, Construction de L'Edifice Moléculaire; Association des Atomes, Chaînes Ouvertes et Chaînes Fermées. Groupements Fonctionnels. Représentation des Édifices Chimiques. Isomérie. Nomenclature.*
By P. Bary, M. Delépine, Ch. Dufraisse, G. Dupont, V. Grignard, M. Lecat, R. Locquin, Ch. Mauguin, H. Pariselle, J. Timmermans. Published under the direction of V. Grignard and Paul Baud. Masson et Cie, Paris. 220 francs. $9\frac{3}{4}$ x $6\frac{1}{4}$; xix + 1149; 1935.

This is the first volume of adidactic and critical work on organic chemistry which will ultimately comprise 15 volumes. It is the first book of an encyclopaedic nature to be published in French in this field since that of Béhal and Valeur, now long out of print and out of date. Throughout this work the nomenclature of Geneva will be used as far as possible. The several chapters are by specialists in their field. A bibliography follows each chapter, and each volume will be equipped with its own indices—authors cited, substances by names and substances by formulae.

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CLINICAL DIAGNOSIS BY LABORATORY METHODS. *A Working Manual of Clinical Pathology. Eighth Edition, Thoroughly Revised.*
By James C. Todd and Arthur H. Sanford. W. B. Saunders Co., Philadelphia. \$6.00. $9\frac{1}{8}$ x $5\frac{3}{4}$; 792; 1935.

This well-known text on clinical laboratory technique has been revised by the addition of a new chapter on clinical chemistry; by the reorganization and extension of the material on blood chemistry; by the discussion of pathogenic organisms not discussed in earlier editions, and by the addition of 25 new illustrations. The chapter on clinical chemistry discusses methods for the determination of fibrinogen, cholesterol, sugar tolerance evaluations, blood salts and other such matters.

This edition has a workmanlike appearance and will undoubtedly retain and increase its present popularity.

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L'Électroactivité dans la Chimie des Cellules. *Actualités Scientifiques et Industrielles, 244. Exposés de Biophysique, II. By René Wurmser. Hermann et Cie, Paris.* 18 francs. 10 x 6½; 82; 1935 (paper).

A presentation of the methods and results of recent work on the electro-chemical equilibrium of cells and on the oxidation-reduction potentials of diastases. A chapter each is devoted to the application of the principle of Nernst and the electrometric method for the determination of the constants of equilibrium. A bibliography of 96 titles is appended.

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Natriumgebrek bij Ratten. (*Sodium Deficiency in Rats.*) *By P. Schoorl. N. V. Uitgevers-Maatschappij, Deventer.* F. 2.50. 9½ x 6¼; 90; 1934 (paper).

These experiments show the effects of sodium deficiency in rats. Since their intake of food and digestion is practically unchanged it is felt that the decrease in growth is a result of increased nitrogen metabolism. The sodium deficient rats showed greater activity and their body temperatures were subnormal.

SEX

The Sexual Relations of Mankind. *By Paolo Mantegazza. Translated from the Latest Italian Edition, as Approved by the Author, by Samuel Putnam. Edited with an Introduction by Victor Robinson. Eugenics Publishing Co., New York.* $3.00. 9½ x 6¼; xxiv + 335; 1935.

Any realistic book on the sex life and practices of primitive peoples has a certain value and this one by Mantegazza is no exception. That it has proved generally interesting to its readers is attested by the fact that the book is now in its eleventh Italian edition and has been recently translated into English. The volume deals with such topics as the festivals of puberty; the sexual embrance and its forms; various types of sexual perversions; rites and customs associated with marriage, prostitution, monogamy, polygamy and polyandry, etc.

There are several criticisms which can be made of the work. In the first place, it is not as readable as it might be. Much of the text sounds simply like a log of isolated and uncorrelated observations, which detracts from its literary smoothness. Also most of the data presented are based on extremely old observations: most of the references cited date around 1850 to 1875. Lastly, there is an annotated appendix at the end of the book which does not seem to be accurately linked up with the specific cross-references in the text.

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Birth Control and Its Opponents. *By Frank W. White. John Bale, Sons and Danielsson, London.* 3s. 6d. net. 7⅛ x 4¾; xi + 164; 1935.

In this little volume Mr. White makes a strong plea for birth control. He examines the populations of the past, how they have been regulated by wars, pestilence and famine, and the populations of the present, how they have grown because of modern hygiene, and may in the future increase enormously if wars are abolished. He argues that the outstanding benefits to be derived from an intelligent employment of birth control "will completely revolutionize the whole of human affairs, making life for the masses a fuller, higher and altogether better thing." Two chapters are devoted to the nature of the opposition to birth control and the arguments put forth by the Church, war lords and a certain type of capitalist. Since the vast bulk of the well-to-do are themselves actively practicing birth control he finds that the opposition is really expending all its energies in an attempt to withhold the methods of birth control from the poor and unfortunate. The volume is without index. Lord Horder contributes a foreword.

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GLÁNDULAS ENDOCRINAS Y PROSTITUCIÓN.
By J. J. Beretervide and S. Rosenblatt. "El Ateneo," Calle Córdoba 2099, Buenos Aires. 9 x 6½; 254; 1935 (paper).

The authors have obtained fairly complete personal histories of 110 prostitutes who were also subjected to a thorough physical examination including the usual tests of endocrine function. In the opinion of the authors, the findings indicate that in the majority of these women there occurs hyperactivity of the sexual glands and the pancreas and hypoactivity of the pituitary, adrenals and parathyroids. The thyroid is usually normal in function. It is to be noted that most of these women are illiterate or semi-literate, of poor families, etc. The general conclusion, cautiously advanced, is that for these women the social and economic factors merely act as a stimulus towards the realization of their endocrine constitution.

* * *

L'IMPUISSANCE SEXUELLE CHEZ L'HOMME. *Étiologie. Diagnostic. Traitement.*
By M. Palazzoli. Masson et Cie, Paris. 45 francs. 10 x 6½; vii + 284; 1935 (paper).

Male sexual impotence is here considered as a clinical entity and the author emphasizes its organic causes. The first part of this book fully describes the act of copulation, the anatomic structures involved and the probable physiologic reactions that take place. In the second part the author discusses the different forms of impotence and their presumed organic and psychic causes. The third part is on therapy. Without doubt this is a valuable book for the clinician but it also deserves to be read by the human biologist, since the author makes apt comments on a number of sex problems.

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LA FECONDITÀ LEGITTIMA DELLA DONNA SECONDO L'ETÀ.
By Giovanni Lasorsa. Antonio Milani, Padova. L. 15. 9¾ x 7; vi + 81; 1934 (paper).

The author has calculated the age specific birth rates (number of children born to 1000 married women of each age group) for Sweden (1891, 1921), Australia (1911), Budapest (1891, 1895), Berlin (1891), Rome (1895), Trieste (1900), Milan (1931), Turin (1931), Venice (1931). For each of these groups, the distribution of the rates, in order according to increasing age of the mothers, is found to be well represented by a third order parabola. This volume presents the actual and calculated data.

* * *

SEX WORSHIP AND DISEASE (*Phallic Worship*). *A Scientific Treatise on Sex Worship and Its Influence on Religion and Symbolism, with Special Reference to Disease of the Sexual Organs.*
By Mason Daugherty. Mason Daugherty, 7909 Euclid Ave., Cleveland. $3.50. 7 x 4½; 240; 1935.

This booklet contains a pot-pourri of odds and ends about sex matters culled from several well-known sources, including the Bible. It might appeal to adolescents.

BIOMETRY

THE RANGE OF HUMAN CAPACITIES.
By David Wechsler. The Williams & Wilkins Co., Baltimore. $2.50. 8⅞ x 5⅞; ix + 159; 1935.

The author proposes that human variability be measured by the ratio: maximum/minimum and discusses its statistical and biological significance. Though it seems strange that the proposed constant has not been used before, a superficial review of statistical literature confirms the author's assertion that his is the first publication in which it is mentioned. As a matter of record, it is well to recall that on April 27, 1935, at the sixth annual meeting of the American Association of Physical Anthropologists, Dr. Raymond Pearl read a paper entitled *Biometric Methods in Anthropometry*, in which he advocated the use of this same ratio, discussed its biological meaning, presented the results of application to about 700 series of measurements, and correlated these results with those obtained by the use of the coefficient of variation.

In the actual computation of this ratio the author uses as minimum and maximum respectively the second and 999th individual per thousand. The interval between the second and 999th is regarded by him as the range of normal variation. The author is of course free to use what limits seem more appropriate to him, but he goes further and attempts to give a rational justification of its use. This is unfortunate. Furthermore, he apparently does not foresee the case of J-shaped or other asymmetrical curves. The author has calculated this ratio for 89 series of measurements of human traits and finds that the values of this constant vary from 1.03 to 3.87. The frequency distribution of these ratios shows modes at the classes 1.20–1.29, 1.50–1.59, 2.00–2.09, and 2.50–2.59. The author believes that "all these modes may be looked upon as significant human constants. . . . " He is of the opinion that the value 2 is of special significance and discusses it at length. One can make a number of objections to such a statement. The principal objection is that this ratio, like all measures of variation, is affected by the scale of measurement. For example, the author finds this ratio = 1.03 for body temperature when measured in Fahrenheit degrees. If a centigrade scale had been used the ratio would have been different. Similarly for the blood pH this ratio is small because the pH is expressed in logarithms; a very different ratio would have been obtained if the antilog. were used. Since Pearl's data showed values of 30 and above for certain traits, it is probable that as the author increases the number of series his views on the significance of the modal values will also alter.

This book contains a number of interesting observations on the subject of variation and some valuable data. However, with regard to this ratio the author has apparently allowed himself to be carried away by his own enthusiasm.

THE DESIGN OF EXPERIMENTS.

By R. A. Fisher. Oliver and Boyd, Edinburgh. 12s. 6d. net. $8\frac{3}{4}$ x $5\frac{1}{2}$; xi + 252; 1935.

The most effective use of the statistical methods expounded in Fisher's well known *Statistical Methods for Research Workers* depends upon a suitable design of the experiment to which the methods are to be applied. In consequence successive editions of that work have contained more and more detailed expositions of the technique of agricultural experimentation. Realizing, however, that the design of experiments is too important a subject for any incidental treatment to be adequate, Fisher has now written the present book, devoted to the study of experimental designs which have been successful in many fields of work and of the basic principles underlying them.

It is often stated in discussions of scientific methodology that only one essential factor at a time should be allowed to vary. As Fisher points out, this neglects the possible interactions of factors. In an agricultural experiment the yield of a crop for different amounts of nitrogen supplied in fertilizer may depend on the amount of phosphorus supplied. If the phosphorus ration in all the experimental plots is held constant there is no way of testing this possible interaction. On the other hand, if we hold the phosphorus ration constant within groups of plots but vary it from group to group, not only will the functional relation of yield to nitrogen and to phosphorus separately be determined with as great precision as if one factor alone had been tested, but any interaction between the two factors will be made plain. The book contains bibliographies and an index.

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Statistical Procedures and Their Mathematical Bases.

By Charles C. Peters and Walter R. Van-Voorhis. School of Education, Pennsylvania State College, State College. \$1.50. $8\frac{1}{4}$ x $5\frac{1}{4}$; vii + 363; 1935.

The aim of this excellent textbook is to give the mathematical development of the standard statistical formulae in such a manner that persons who have studied only high school mathematics can follow it. The introductory chapter explains so much of calculus as is needed in the subsequent proofs, while the latter are given in such detail that the inexperienced student will not be confronted with an "it is obvious" which to him is by no means obvious. Although the intention of the authors is to show the derivation of the conventional formulae rather than to derive new ones, a few new methods are developed. Among these are tetrachoric and bi-serial correlations where only the two tails of one of the distributions are known. Exercises and references are given at the end of each chapter, and the appendices give tables of the normal probability integral and for use in tetrachoric correlation. The book will be found useful both as a text in mathematical statistics and as a reference book.

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Statistical Method in Education.

By Charles W. Odell. D. Appleton-Century Co., New York. \$3.50. $7\frac{7}{8}$ x $5\frac{1}{4}$; xx + 457; 1935.

This book is "designed to meet the statistical needs of those interested in the field of education by presenting the subject in a manner as non-mathematical as possible." The subjects treated are tabulation and classification, graphic representation, the normal and other frequency curves, averages, quartiles, percentiles and similar measures, measures of variability, correlation and regression of both zero and higher orders, and the reliability of statistical constants. Besides numerous bibliographical footnotes, a general bibliography of four pages, tables of the normal probability curve and indexes are given.

PSYCHOLOGY AND BEHAVIOR

Growth: *A Study of Johnny and Jimmy.*

By Myrtle B. McGraw. D. Appleton-Century Co., New York. \$3.50. 9 x $5\frac{3}{4}$; xxi + 319 + 20 plates and 5 folding graphs; 1935.

The much publicized investigation on the developmental behavior of a pair of twins is here reported in detail. As is known, one of the twins (Johnny) was, for a period of time since birth, stimulated to certain physical activities while the other (Jimmy) was kept more or less inactive for the same period and only at a later date given the training that his brother had received. The essential results are that for those "action-patterns [which] are, on the whole, indispensable to normal human functioning and stand as landmarks in the development of the human species" the effects of training were practically nil when considered in terms of time of onset and rate of progress. But for such activities as swimming, roller-skating, etc. Johnny developed more rapidly and showed greater proficiency than Jimmy. However, when towards the end of the experimental period (over 24 months) both children were presented simultaneously with new types of problems also involving motor functions, both reacted in practically the same manner.

In addition to the report of this unique experiment, which of course does not permit generalizations, the author discusses at great length and clearly, various aspects of the development of behavior-patterns.

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Adult Interests.

By Edward L. Thorndike and the Staff of the Division of Psychology of the Institute of Educational Research of Teachers College, Columbia University. The Macmillan Co., *New York.* \$3.25. $7\frac{3}{4}$ x $5\frac{1}{8}$; ix + 265; 1935.

This book reports a part of the extensive and intensive study of the problems of adult education that has been going on under the author's direction for a number of years. Chapter V reports some interesting experiments leading to the following conclusions:

> As the representative results described above show, the rate of learning does not suffer greatly even when what is learned is utterly valueless to the learner. Extrinsic interests are adequate to maintain learning when intrinsic interests are not available or require an undue expense of time, labor, or skill on the part of the teacher.
>
> On the whole, we may conclude from the experiments that when certain unpalatable mental medicines need to be taken, too much time and pains should not be taken to disguise them. If a stretch of dull learning can be learned as it is in ten hours, it will usually not be profitable to spend five hours in making it so interesting that it can be learned in seven.

There are chapters on changes of intensity of interest with age, differences between young and old interests and attitudes, and interest and the curriculum of part-time adult education.

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A Dynamic Theory of Personality. *Selected Papers.*

By Kurt Lewin. Translated by Donald K. Adams and Karl E. Zener. McGraw-Hill Book Co., New York. \$3.00. 9 x $5\frac{3}{4}$; ix + 286; 1935.

For the most part the Gestalt school of psychologists have dealt with problems of perception and learning rather than with the more difficult, but none the less important, fields of will, emotion and character. Lewin, however, has extended the Gestalt viewpoint to the investigation of the latter subjects. In the first article of the present book he elaborates the idea that as physics developed from an Aristotelian viewpoint full of valuative concepts—e.g. circular orbits as the highest form of motion—and tending to identify the individual with the accidental to a Galileian viewpoint which rejects valuative concepts and regards the individual as well as the regular and uniform as being subject to law, so psychology is about to pass through an analogous development. Other articles deal with the structure of the mind, environmental forces in child behavior and development, the psychological situation of reward and punishment, education for reality, substitute value, a dynamic theory of the feebleminded, and a survey of the experimental investigations of his school. The book contains bibliographical footnotes and an index.

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The Evolution of Modern Psychology.

By Richard Müller-Freienfels. Translated by W. Béran Wolfe. Yale University Press, New Haven. \$5.00. 9 x 6; xvi + 513; 1935.

Müller-Freienfels has written a first-rate history of the development and critical interpretation of practically every school of modern psychology (individual, social and racial) plus a few less authentic offshoots such as telepathy, palmistry and astrology. He not only traces their development one from another, but gives an unbiased evaluation of their contributions, and points out their differences, similarities, and shortcomings. The book is, it seems to us, one of the most adequate and stimulating of its kind, and due to its non-pedantic style is suitable for the intelligent layman as well as the psychologist and psychiatrist. It is indeed fortunate to have this book made available to English readers in so competent a translation as this one. A bibliography and author and subject indices are included.

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Psychology of Learning. *A Textbook in Educational Psychology.*

By Robert A. Davis. McGraw-Hill Book Co., New York. \$3.00. 8 x $5\frac{1}{2}$; xii + 489; 1935.

A first rate text-book for an advanced course in educational psychology. The chief purpose of the book is to give students an opportunity to consider critically studies with somewhat divergent results as well as some of the many theories advanced on disputed facts. The important works and many of the more promising theories on the psychology of learning processes are reviewed and critical suggestions offered. Many of the studies are presented in tabular and graphic form with the essence of each set forth "in a brief space in such a way as to enable the reader to obtain the trend of them all, if there is a trend, or to be sure that the whole question is unsettled because of the mélange of results." The volume is documented and contains an index of authors and of subjects.

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Child Psychiatry.

By Leo Kanner. Charles C Thomas, Springfield, Ill. $6.00. 9$\frac{7}{8}$ x 6$\frac{3}{8}$; xviii + 527; 1935.

This book, with prefaces by Dr. Adolf Meyer and Dr. Edwards A. Park, is a thorough analysis of the difficulties of childhood. The author deals fully and sympathetically with the various mental disorders of children from the very young to the adolescent, and covers every subject from thumb sucking to sexual practices. His theories are amply illustrated by numbers of actual and interesting cases with which he has come in direct contact. An important book.

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La Démence.

By Raymond Mallet. Armand Colin, Paris. 10.50 francs (paper); 12 francs (cloth). 6$\frac{3}{4}$ x 4$\frac{1}{2}$; 176; 1935.

A short treatise on the clinical, anatomic, pathogenic and therapeutic aspects of the different types of mental disorder, with particular reference to newer developments in diagnosis and treatment. An attempt is made at classification of the various types by beginning and terminal stages. There is a short bibliography and an index of names.

DE OMNIBUS REBUS ET QUIBUSDEM ALIIS

La Matière.

By Georges Lakhovsky. Gaston Doin et Cie, Paris. 24 francs. 7$\frac{1}{2}$ x 5$\frac{1}{2}$; 232; 1934 (paper).

This book is about the *Universion*. "Universion" is a French portmanteau word, made up of *univers* and *ion*—as simple as that. But, ah, what it means! It is a non-material force which occupies intermolecular space, and is, in the end, to be identified with God. Lakhovsky's view is that the density, mass, and radiation of each material body from stars to atoms are functions of the *compression* created by this body in the *universion*, and this *compression* provokes a perpetual dynamism which accounts for the motion of the bodies. [Reginald, the Office Boy, whose attitude towards sacred and spiritual matters regrettably gets less reverent as he grows older, says that he tried substituting God for universion in the preceding sentence according to directions, and got as a result a wonderful picture of Divine Borborygmus. He thinks that the author should introduce bicarbonate of soda somewhere into his cosmic system.]

What the good old universion can do for us may be illustrated by the following passage which appears in the chapter on Universion—Light—Heat.

> One can then comprehend that a person born on our Earth fifty years ago and still living is multiplied to infinity on all those planets where his complex of radiations has gone to be materialized at different times. It is thus, for example, that a man sixty years of age, who at the end of his earthly life, can be born again at this moment on another earth seventy light years distant from our globe. And this can be repeated to infinity in space and time. Human life will therefore appear on different planets as a series of successive and eternal resonances.
>
> In the light of the preceding, one should be able to give every appeasement to scholars who are confronted with unsurmountable difficulties in conciliating their scientific principles and religious scruples.
>
> Thus the miracles reported by religion, particularly the dogma of the Immaculate Conception, can be explained as the result of the action of the materialization of a higher Being by the condensation of radiation emanating from the Universion-God on our Earth.

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A History of Science, Technology, and Philosophy in the 16th and 17th Centuries.

By A. Wolf, with the co-operation of F. Dannemann and A. Armitage. The Macmillan Co., New York. $7.00. 9$\frac{3}{4}$ x 6; xxvii + 692 + 68 plates; 1935.

This excellent history well fulfills its dual purpose of being of use both to the general reader and to the serious student. The description is in sufficient detail to enable the reader to understand what the various scientists were really doing. The author deals not only with astronomy, mathematics, mechanics, physics, meteorology, chemistry, geology, geography, the biological sciences, and medicine, but with technology, psychology, the social sciences, and philosophy. Over 300 well chosen illustrations add to the interest of the book. Bibliographic references are included in the text.

This is intended to be the first of three volumes, of which one will deal with the eighteenth and nineteenth centuries and one with ancient and medieval times. We wish Professor Wolf all success in the completion of a work which will be of great value to those interested in our cultural heritage.

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THE ENDLESS QUEST. *Three Thousand Years of Science.*

By F. W. Westaway. Blackie and Son, Toronto and London. \$7.00 (Canada); 21 shillings (Great Britain). $8\frac{1}{2}$ x $5\frac{7}{8}$; xx + 1080 + 51 plates; 1934.

This book is as intriguing as its title from the first chapter on the "Geography of the Ancient World" to the last on "The Passing of Dogmatism." It is necessarily rather brief in some of its parts due to the wide scope of the whole, but the reader is given an absorbing moving picture of the history and development of science through the ages. Throughout the book stress is laid on the laboratory and field work of history in contrast to the theoretical and speculative. The material is presented in a critical fashion that draws the reader into valuing for himself the evidence by which the inferences are supported. Books for reference are listed at the end of each chapter, and there is an extensive subject index as well as a name index.

LA PENSÉE ET LE MOUVANT. *Essais et Conférences. Cinquième Edition.*

By Henri Bergson. Félix Alcan, Paris. 25 francs. $8\frac{7}{8}$ x $5\frac{1}{2}$; 324; 1934 (paper).

In the first two essays of this volume, which are hitherto unpublished, Bergson outlines the method which he believes is appropriate for the development of philosophy and repels the charge of anti-intellectualism and hostility to science which has often been made against him. Science and metaphysics, in his view, are coördinate; the former by the use of the intellect deals with matter, the latter by the use of intuition deals with mind. The other essays and lectures have as subjects the possible and the real, philosophical intuition, the perception of change, introduction to metaphysics, the philosophy of Claude Bernard, the pragmatism of William James, and the life and work of Ravaisson, the French philosopher and educator.

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HANDBOOK OF TRAVEL. *Second Edition, Revised and Enlarged.*

Prepared for the Harvard Travellers Club; Edited by Geo. C. Shattuck. Harvard University Press, Cambridge, Mass. \$3.00. $6\frac{7}{8}$ x $4\frac{3}{4}$; viii + 510; 1935.

Much of this handbook is designed for the traveler in countries without benefit of Cook's or the American Express Company. The prospective explorer can find here useful information on planning a caravan or sledding expedition, packing a dromedary, dealing with native servants, etc. The traveler in less remote regions will be repaid for reading the chapters on automobiles, canoes, motor boats and sail boats. Besides this discussion of methods of travel, information is given on camping; photography; recording of geographical, geological, anthropological and meteorological observations; collecting of zoölogical and botanical specimens; and hygiene, medicine and surgery. Brief bibliographies are appended to many of the chapters and a detailed index is given. A useful book.

THE WORK OF SCIENTISTS.
By Edith M. Patch and Harrison E. Howe. The Macmillan Company, New York. 76 cents. $7\frac{1}{4}$ x $5\frac{3}{8}$; viii + 488; 1935.

This book deals with the sciences and their application to modern life. It should prove interesting and instructive to children of primary school age.

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UNIVERSITY OF COLORADO STUDIES, *Volume 22, Number 4.* Containing following articles: *The Observance of Holidays and Vacations by the Lower Exchequer, 1327–1336*, by James F. Willard; *Contemporary Life in Two Twelfth-Century Saints' Legends*, by Irene P. McKeehan; *Some Observations on the So-called "Plural Majesty" or Plural of Reverence*, by Edwin B. Place; *On Certain Adverbial and Semi-adverbial Uses of "bel," "beau" in Old French*, by Paul-Louis Faye; *Anglo-Latin Scholarship, 597–780*, by Jack D. A. Ogilvy; *Tacitus through the Centuries to the Age of Printing*, by Mary F. Tenney; *Bishops and Monastic Finance in Fourteenth-Century England*, by Harold E. Aikens; *Chancery and Exchequer Clerks serving as Attorneys, 1327–1336*, by Thomas W. Simons.

University of Colorado Press, Boulder. $1.00. 10 x $6\frac{7}{8}$; 116; 1935 (paper).